



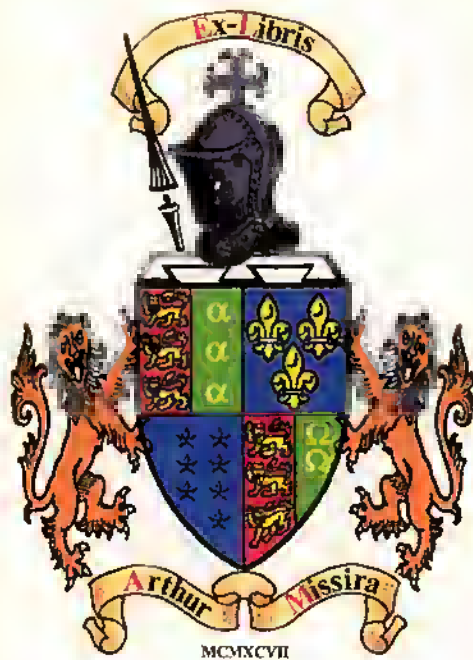
MOTOROLA
Semiconductors

master selection guide

master selection guide

**JEDEC
PRO-ELECTRON**







MOTOROLA
Semiconductors

SELECTING THE BEST SEMICONDUCTOR

Selecting the best semiconductor for a given application can pose a significant challenge. To simplify the task in selecting a "best" transistor, diode or other device for new designs, this book's selection tables include all popular Motorola semiconductor devices and applications. These guides permit a quick comparison of the preferred devices, and a pre-selection of semiconductors that are most suitable.

The selection tables are arranged to highlight the prime selection criteria in easy-to-use order. Since the important characteristics depend on the type of device, the selection tables take different forms. In silicon rectifiers, for example, peak reverse voltage, and average forward current are the basic criteria, and the devices are listed in order of these ratings. For other devices, such as transistors, other important characteristics or suggested applications are specified in their particular section.

The selection tables include only basic specifications. For complete information contact your nearest Motorola sales office or franchised distributor.

Beam-Fired, BET, CHAINMAKER, C.Q., Deke-Pek,
Designer's, Econocap, Epibase, Epicap, EXbug, EXORciser,
EXORDisk, EXORtape, Gletselveted, HANDY Lab®, HEP®,
LocaLogic, Isothermal, Llmellight, McMOS, Meg-A-Life II,
MEGALOGIC, MDTL, MECL, MECL 10,000, MECL III,
MHTL, Micro-T, MIOA, MIKbug, MINibug, Minfode,
Mini-T, MLED, MMOS, MRTL, mW MRTL, MNMOS,
MTTL, Multi-Cell II, Multi-Pek, OUIL, RemRod, Red Head,
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INDEX

INTEGRATED CIRCUITS

| | |
|--|------|
| MOS INTEGRATED CIRCUITS | 1-1 |
| M6800 Microcomputer Family (including MCM6800's) | 1-2 |
| MOS RAM's (excluding MCM6800's) | 1-5 |
| MOS ROM's (excluding MCM6800's) | 1-6 |
| McMOS MC14000 and MC14500 Series | 1-7 |
| McMOS MC14400 Series | 1-8 |
| BIPOLAR DIGITAL INTEGRATED CIRCUITS | |
| MECL MC10,000 Series | 2-2 |
| MECL III MC1600 Series | 2-4 |
| MEGALOGIC LSI | 2-5 |
| Logic Products for Phase-Locked Loop Applications | 2-6 |
| MHTL MC660 Series | 2-7 |
| MDTL MC830/MC930 Series | 2-8 |
| (Includes MC1800/MC1900 Series Devices) | |
| MRTL MC700/MC800/MC900 Series | 2-10 |
| (Includes MC9700/MC9800 Series Devices) | |
| mW MRTL MC708/MC808/MC908 Series | 2-11 |
| (Includes MC9700/MC9800 Series Devices) | |
| MTTL Beam Lead Integrated Circuits (MCBC5400 Series) | 2-12 |
| MTTL Dielectrically Isolated Integrated Circuits | 2-13 |
| (MCE54H00/MCE74H00 Series, MCE5400/MCE7400 Series) | |
| MCE7000 Series Dielectrically Isolated Integrated Circuits | 2-13 |
| MDTL Dielectrically Isolated Integrated Circuits | 2-14 |
| (MCE930 Series) | |
| Special Bipolar Logic Products for Custom Applications | 2-15 |
| LINEAR INTEGRATED CIRCUITS | |
| Interface Circuits | 3-2 |
| Operational Amplifiers | 3-14 |
| High-Frequency Amplifiers | 3-17 |
| Regulators | 3-19 |
| Special-Purpose Circuits | 3-21 |
| Consumer Devices | 3-22 |
| Linear IC Packages | 3-25 |

DISCRETE SEMICONDUCTORS

| | |
|--|-------|
| AMPLIFIERS | |
| Reference | 4-81 |
| CHIPS | 4-113 |
| Virtually every device manufactured by Motorola is available in chip form. | |
| Contact your Motorola representative for more information. | |
| DIODES | |
| 4-Layer | 4-105 |
| Avalanche Regulator | 4-77 |
| Current Regulator | 4-80 |
| Dual | 4-82 |
| Epicap Tuning | 4-66 |
| Forward Reference | 4-82 |
| Hot-Carrier | 4-72 |
| Hyper-Abrupt Junction Tuning | 4-70 |
| PIN Switching | 4-72 |
| Plastic Hot-Carrier | 4-72 |
| Precision Reference | 4-81 |

| | |
|---|------------------|
| Temperature Compensated Zener Reference | 4-82 |
| Transient Suppressor | 4-83 |
| Tuning Diode | 4-86 |
| Voltage Regulator | 4-81 |
| Zener Diodes Device Options | 4-76 |
| Zener | 4-77 |
| Zener Reference | 4-79 |
| MICRO-T TRANSISTORS AND DIODES | 4-47 |
| OPTOELECTRONICS | |
| Couplers/Isolators | 4-109 |
| Detectors | 4-111 |
| Light-Emitting Diodes | 4-110 |
| RECTIFIERS | |
| Bridges | 4-89 |
| Fast Recovery | 4-91 |
| General-Purpose | 4-86 |
| High Current Multi-Cell Diodes | 4-88 |
| High Current Multi-Cell Circuits | 4-90 |
| Hot-Carrier Power | 4-92 |
| Special Purpose | 4-93 |
| RF MODULES | |
| Hybrid Amplifier | 4-61 |
| THYRISTORS | 4-95 |
| TRANSISTORS | |
| Field-Effect | 4-29 |
| Multiple and Darlington | 4-35 |
| Plastic Encapsulated Small-Signal | 4-21 |
| Small-Signal Hermetic | 4-13 |
| Silicon Power | 4-2 |
| Silicon RF | 4-51 |
| Silicon Power Voltage Regulator | 4-10 |
| Unijunctions | 4-104 |
| TRIGGERS | |
| 4-Layer Diodes | 4-105 |
| Diacs | 4-105 |
| Silicon Bidirectional Switch | 4-105 |
| Silicon Unidirectional Switch | 4-105 |
| DEVICES FOR MILITARY APPLICATIONS | 5-1 |
| APPLICATION NOTE SELECTION GUIDE | 6-1 |
| ENGINEERING BULLETIN SELECTION GUIDE | 6-4 |
| CATALOG INDEX | 7-1 |
| PDPULAR PRO-ELECTRON DEVICE TYPES | Section 8 |
| Small Signal Transistors, TO-92 | 1 |
| Small Signal Transistors, TO-5, TO-18, TO-39 | 7 |
| Power Transistors, Case 77, 90, TO-3, TO-39 (Uni watt, Duowatt) | 8 |
| RF Transistors, SOT-2, TO-72, (See also TO-92 Types) | 11 |
| Zener Diodes | 11 |
| Rectifiers Products | 12 |
| Special Purpose Diodes | 13 |
| Linear Integrated Circuits | 14 |



MOS

INTEGRATED CIRCUITS

MOS INTEGRATED CIRCUITS

Motorola's MOS Lines range from standard SSI to MSI and LSI functions. Most devices are available in two temperature/voltage ranges, and in both plastic and ceramic packages. Over 200 different devices are offered.

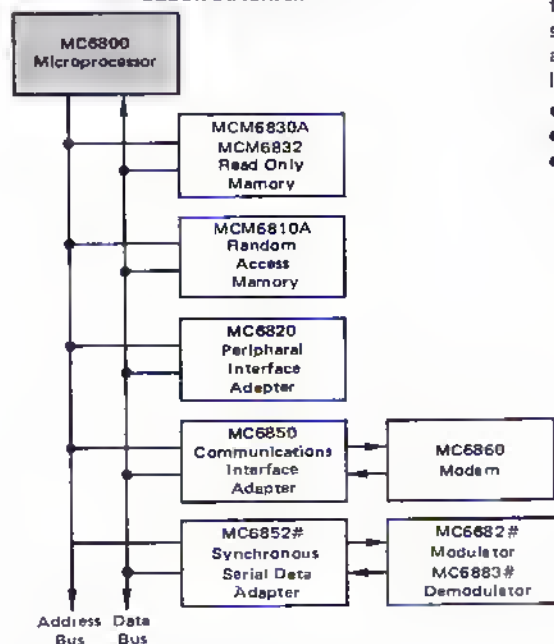
The two major MOS lines include complementary MOS (McMOS) and NMOS Circuits.

The McMOS family is available in a wide variety of basic and complex logic functions at medium speeds and very low power dissipation.

The NMOS products include the M6800 microcomputer components and an array of memory devices. RAMs, ROMs, Character generators, and unique microcomputer parts, such as Peripheral Interface Adapter (PIA), Asynchronous Communications Interface Adapter (ACIA), and MODEM are part of this series.

TABLE OF CONTENTS

| | Page |
|--|------|
| M6800 Microcomputer Family (Including MCM6800's) | 1-2 |
| MOS RAMs (Excluding MCM6800's). | 1-5 |
| MOS ROMs (Excluding MCM6800's). | 1-6 |
| McMOS MC14000 and MC14500 Series. | 1-7 |
| McMOS MC14400 Series. | 1-8 |

M6800 MICROCOMPUTER FAMILY
BLOCK DIAGRAM

The M6800 family of parts has been designed to set the standard for microcomputer system architecture. The family provides total-system building functions, yet is designed with the flexibility to allow growth. Programmable logic is designed to replace hardwired logic and costly custom microcomputer functions.

- Minimum System Approach
- Powerful Instructions
- Comprehensive Support:
 - Systems Development Tools
 - Software
 - Documentation
 - Applications Aid

CERAMIC PACKAGE
CASE 684CERAMIC PACKAGE
CASE 699

FUNCTIONS AND CHARACTERISTICS

| Function | Type | Case | Comments |
|---|----------|------|--|
| Microprocessor | MC6800L | 699 | Monolithic 8-bit MPU forming the central control function for the M6800 family. Bi-directional data bus, 8-bit parallel processing, 10-bit address bus capable of addressing 8K bytes of memory, 72 instructions, DMA and multiple processor capability. |
| Peripheral Interface Adapter | MC6820L | 699 | Interfaces MPU to peripherals through two 8-bit bi-directional peripheral data buses and four control lines. Programmed by the MPU during system initialization. |
| Asynchronous Communications Interface Adapter | MC6850L | 684 | Provides the data formatting and control to interface serial asynchronous data communications information to bus organized systems. Programmable control register provides variable word lengths, clock division ratios, transmit control, receive control, and interrupt control. |
| Synchronous Serial Data Adapter# | MC6852L# | 684 | Provides a bi-directional interface for simultaneously transmitting and receiving standard synchronous communications characters. Programmable control for variable word lengths, synchronization, and interrupt. |
| Digital Modem | MC6860L | 684 | Provides necessary modulation and control to implement serial data communications link, over voice-grade channel, utilizing FSK at bit rates to 600 bps. |
| 2400 bps Digital Modulator # | MC6862L# | 684 | Provides necessary modulation and control to implement serial data communications link, over voice-grade channel, utilizing DPSK at bit rates of 1200 or 2400 bps. |
| 2400 bps Digital Demodulator# | MC6863L# | 684 | Provides necessary demodulation and control to implement serial data communications link, over voice-grade channel, utilizing DPSK at bit rates of 1200 or 2400 bps. |

#To be announced.

THE M6800 MICROCOMPUTER FAMILY (continued)

| Device No. | No. of Bits | Description | Organization | Access Time (ns max) | Power Supplies (V) | No. of Pins | Case |
|---|-------------|---------------------------------------|--------------|----------------------|--------------------|-------------|----------|
| RANDOM ACCESS MEMORIES (Silicon Gate NMOS) | | | | | | | |
| MCM6810A | 1024 | Static | 128 x 8 | 500 | +5 | 24 | 684 |
| MCM68111A# | 1024 | Static, Common I/O and Output Disable | 256 x 4 | 450 | +5 | 18 | 680, 707 |
| MCM68112A# | 1024 | Static, Common I/O | 256 x 4 | 450 | +5 | 16 | 620, 648 |
| MCM6815A# | 4096 | Dynamic | 4096 x 1 | 300 | +12, +5, -5 | 22 | 677, 708 |
| MCM6815A2# | 4096 | Dynamic | 4096 x 1 | 200 | +12, +5, -5 | 22 | 677, 708 |

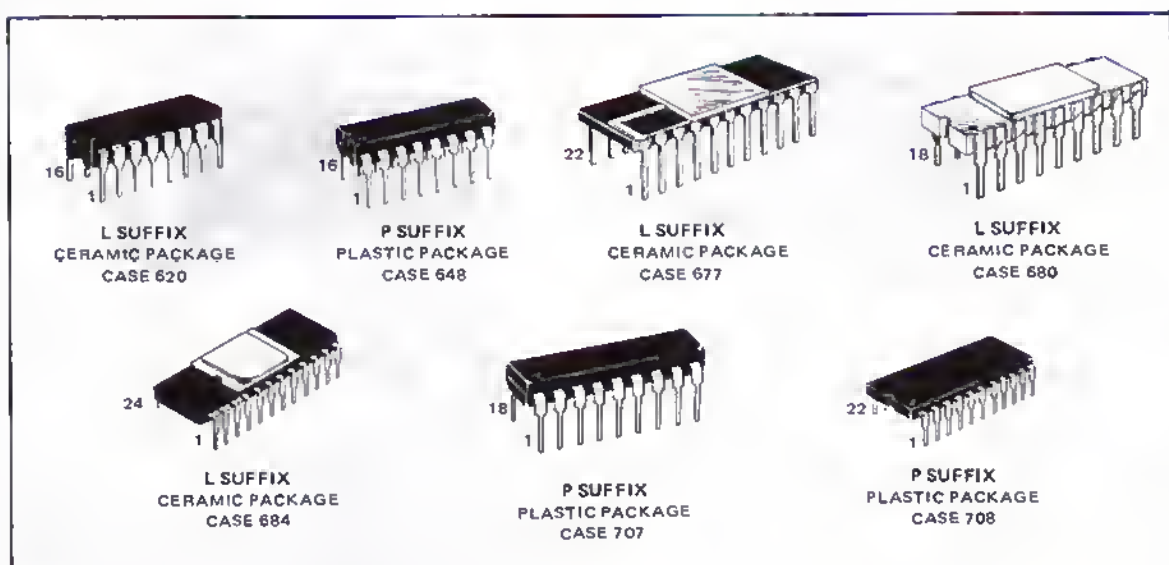
READ ONLY MEMORIES (Silicon Gate NMOS unless otherwise noted)

| | | | | | | | |
|------------|-------|-------------------|----------|-----|-------------|----|-----|
| MCM6830A* | 8192 | Mask-Programmable | 1024 x 8 | 500 | +5 | 24 | 684 |
| MCM68317*# | 16384 | Mask-Programmable | 2048 x 8 | 500 | +5 | 24 | 684 |
| MCM6832*† | 16384 | Mask-Programmable | 2048 x 8 | 550 | +12, +5, -5 | 24 | 684 |
| MCM68708# | 8192 | Altable | 1024 x 8 | 500 | +12, +5, -5 | 24 | T8A |

*Mask-programmable ROMs are manufactured according to a bit-pattern supplied by the customer. A special device number (SCMxxxx) is assigned to each individual pattern.

#To be announced

†Metal Gate NMOS



M6800 SYSTEM SUPPORT

Numerous semiconductor devices are available to enhance the capabilities of the M6800 Family of integrated circuits. Among these, the following should be given special attention (characteristics are given in the indicated section of this Master Selection Guide):

| | |
|--|---|
| NMOS Random Access Memories NMOS Read Only Memories | Various sizes and types of MOS memories are available to supplement those in the M6800 Family. |
| MEGALOGIC LSI | These computer-oriented products are a natural complement for MPU-based systems. |
| Linear Interface Circuits | A broad spectrum of interface circuits will be of particular interest to microcomputer system designers. |
| McMOS Integrated Circuits | Many of the newer CMOS devices are specialized functions which fit specific needs of microcomputer systems. |
| MPU Clock Buffer (Multiple Transistor) | The MPQ6842 provides the requirements of the clock buffer for $\phi 1$ and $\phi 2$ inputs of the MPU. |

In addition to the categories listed, Two-Phase Clocks (MC6870A, MC68708, and MC6871A) are available from Motorola Inc., Component Products Department, 2553 North Edgington, Franklin Park, Illinois 60131.

M6800 SYSTEM SUPPORT (continued)

M6800 SUPPORT HARDWARE

EXORciser



Evaluation Module



EXORdisk



EXORtape

| | |
|-------------------|---|
| EXORciser | Ability to emulate a user's system makes the EXORciser an efficient and economical means for development of M6800 Microprocessor Systems. The optional modules can be arranged to represent the user's proposed system, optional Resident Software permits editing, assembling, and modification of programs. |
| Evaluation Module | This complete board has all of the M6800 Family devices for ease of parts evaluation. It can be used to run simple programs for familiarization with the system as well as evaluation prior to actual system development with the EXORciser. |
| EXORdisk | The EXORdisk (Motorola's floppy disk) speeds up microcomputer program development; it is many times faster than teletype or paper tape. |
| EXORtape | The EXORtape (Motorola's high-speed paper tape reader) provides high-speed reading of paper tape for efficient program loading, editing, and assembling. |

M6800 SUPPORT SOFTWARE

Compatible software is available in a variety of forms:

| | |
|------------------------|--|
| Resident Software | Used with the EXORciser or Evaluation Module, this package consists of the Editor — for editing operations on lines or character strings — and the Assembler — which uses a two-pass operation to produce listing and object tape. |
| Commercial Timesharing | M6800 software is available on several commercial timesharing services. As circumstances indicate, others will be added. |
| Host Computer Software | Two software packages are available for host computers: 1. Standard package, normally supplied by vendors; 2. Full capability package, pre-tailored to customer. |



Random Access Memories are useful wherever temporary storage is required. They find application in large mainframe memory systems, minicomputers, and conventional digital control circuits.

RAMs which are specifically intended for use with the M6800 Microcomputer Family are shown in another table.

| Device No. | No. of Bits | Description | Organization | Access Time (ns max) | Power Supplies (V) | No. of Pins | Case |
|--------------------------|-------------|---------------------------------------|--------------|----------------------|--------------------|-------------|----------|
| SILICON GATE NMOS | | | | | | | |
| MCM2102* | 1024 | Static | 1024 x 1 | 1000 | +5 | 16 | 620, 648 |
| MCM2102-1* | 1024 | Static, High Speed | 1024 x 1 | 500 | +5 | 16 | 620, 648 |
| MCM2102-2* | 1024 | Static | 1024 x 1 | 850 | +5 | 16 | 620, 648 |
| MCM2102A* | 1024 | Static, Very High Speed | 1024 x 1 | 350 | +5 | 16 | 620, 648 |
| MCM2102A2* | 1024 | Static, Very High Speed | 1024 x 1 | 250 | +5 | 16 | 620, 648 |
| MCM2102A4* | 1024 | Static, Very High Speed | 1024 x 1 | 450 | +5 | 16 | 620, 648 |
| MCM2111A* | 1024 | Static, Common I/O and Output Disable | 256 x 4 | 350 | +5 | 18 | 680, 707 |
| MCM2111A2* | 1024 | Static, Common I/O and Output Disable | 256 x 4 | 250 | +5 | 18 | 680, 707 |
| MCM2111A4* | 1024 | Static, Common I/O and Output Disable | 256 x 4 | 450 | +5 | 18 | 680, 707 |
| MCM2112A* | 1024 | Static, Common I/O | 256 x 4 | 350 | +5 | 16 | 620, 648 |
| MCM2112A2* | 1024 | Static, Common I/O | 256 x 4 | 250 | +5 | 16 | 620, 648 |
| MCM2112A4* | 1024 | Static, Common I/O | 256 x 4 | 450 | +5 | 16 | 620, 648 |
| MCM6604 | 4096 | Dynamic | 4096 x 1 | 350 | +12, +5, -5 | 16 | 690, 648 |
| MCM6604-2 | 4096 | Dynamic | 4096 x 1 | 250 | +12, +5, -5 | 16 | 690, 648 |
| MCM6604-4 | 4096 | Dynamic | 4096 x 1 | 300 | +12, +5, -5 | 16 | 690, 648 |
| MCM6605A | 4096 | Dynamic | 4096 x 1 | 300 | +12, +5, -5 | 22 | 677, 708 |
| MCM6605A1 | 4096 | Dynamic | 4096 x 1 | 150 | +12, +5, -5 | 22 | 677, 708 |
| MCM6605A2 | 4096 | Dynamic | 4096 x 1 | 200 | +12, +5, -5 | 22 | 677, 708 |
| MCM6616* | 16384 | Dynamic | 16384 x 1 | 350 | +12, +5, -5 | 16 | TBA |

METAL GATE CMOS

| | | | | | | | |
|-----------|-----|-----------------------|---------|-------|-------------|----|----------|
| MCM14505A | 64 | Static, -55 to +125°C | 64 x 1 | 550# | +3 to +18 | 14 | 632 |
| MCM14505C | 64 | Static, -40 to +85°C | 64 x 1 | 650# | +4.5 to +16 | 14 | 632, 646 |
| MCM14537A | 256 | Static, -55 to +125°C | 256 x 1 | 4000# | +3 to +18 | 16 | 690 |
| MCM14537C | 256 | Static, -40 to +85°C | 256 x 1 | 6000# | +4.5 to +16 | 16 | 690 |
| MCM14552A | 256 | Static, -55 to +125°C | 64 x 4 | 3000# | +3 to +18 | 24 | 684 |
| MCM14552C | 256 | Static, -40 to +85°C | 64 x 4 | 6000# | +4.5 to +16 | 24 | 684, 709 |

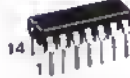
*To be announced

#Measured with $V_{DD} = +5V$, $T_A = 25^\circ C$ 

L SUFFIX
CERAMIC PACKAGE
CASE 620



L SUFFIX
CERAMIC PACKAGE
CASE 632



P SUFFIX
PLASTIC PACKAGE
CASE 648



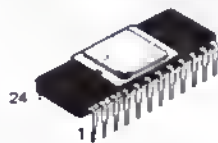
P SUFFIX
PLASTIC PACKAGE
CASE 648



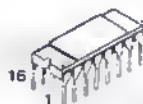
L SUFFIX
CERAMIC PACKAGE
CASE 677



L SUFFIX
CERAMIC PACKAGE
CASE 680



L SUFFIX
CERAMIC PACKAGE
CASE 684



L SUFFIX
CERAMIC PACKAGE
CASE 890



P SUFFIX
PLASTIC PACKAGE
CASE 707



P SUFFIX
PLASTIC PACKAGE
CASE 708



P SUFFIX
PLASTIC PACKAGE
CASE 709



Motorola's Read Only Memories include both pre-programmed memories and mask-programmable memories for custom applications.

The character generators are useful in CRT displays as well as in digital printers. Together with the code converters, which facilitate interface circuitry when going from one character standard to another, they provide a wide choice of devices for data display systems. ROMs are also available to provide the rhythm patterns for electronic organs.

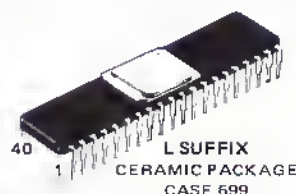
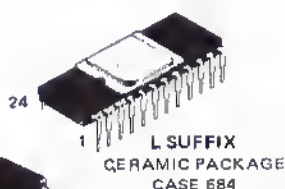
ROMs which are specifically intended for use with the M6800 Microcomputer Family are shown in another table.

| Device No. | No. of Bits | Description | Organization | Access Time (ns max) | Power Supplies (V) | No. of Pins | Case |
|-----------------------------------|-------------|--|------------------------------------|--------------------------|--------------------|-------------|----------|
| METAL GATE NMOS | | | | | | | |
| MCM6550* | 7168 | Mask-Programmable, Static, Rhythm | 16 Patterns of 24 or 32 Beats | $t_{cyc} = 1 \text{ ms}$ | +15, +5, -3 | 40 | 699, 711 |
| MCM6560* | 8192 | Mask-Programmable, Addressable | 1024×8 or 2048×4 | 350 | +12, +5, -3 | 24 | 684, 709 |
| Pre-Programmed Standard Memories: | | | | | | | |
| MCM6561 | | Binary Code Converter | 1024×8 | | | | |
| MCM6562 | | Binary Code Converter | 1024×8 | | | | |
| MCM6570* | 8192 | Mask-Programmable 9 x 7 Character Generator, Horizontal Scan, Shift Capability | $128c \times (9 \times 7)$ | 500 | +12, +5, -3 | 24 | 684, 709 |
| Pre-Programmed Standard Memories: | | | | | | | |
| MCM6571 | | ASCII Characters and Greek, Shifted | | | | | |
| MCM6571A | | ASCII Characters and Greek, Shifted | | | | | |
| MCM6572 | | ASCII and Greek, Not Shifted | | | | | |
| MCM6573 | | Japanese Characters, Not Shifted | | | | | |
| MCM6574 | | Math Symbols and Pictographs, Shifted | | | | | |
| MCM6575 | | Alphanumeric Control Characters, Shifted | | | | | |
| MCM6576 | | British Standard Characters, Shifted | | | | | |
| MCM6577 | | German Standard Characters, Shifted | | | | | |
| MCM6578 | | French Standard Characters, Shifted | | | | | |
| MCM6579 | | General European Standard Characters, Shifted | | | | | |
| MCM6580* | 8192 | Mask-Programmable 7 x 9 Character Generator, Vertical Scan, Shift Capability | $128c \times (7 \times 9)$ | 400 | +12, +5, -3 | 24 | 684, 709 |
| Pre-Programmed Standard Memories: | | | | | | | |
| MCM6581 | | ASCII Characters and Greek, Shifted | | | | | |
| MCM6583 | | Japanese Characters, Not Shifted | | | | | |
| MCM6590* | 16384 | Mask-Programmable, Static | 2048×8 | 800 | +12, +5, -3 | 24 | 684 |
| Pre-Programmed Standard Memory: | | | | | | | |
| MCM6591 | | Universal Code Converter | | | | | |

METAL GATE CMOS

| | | | | | | | |
|------------|------|----------------------------------|----------------|-------|-------------|----|----------|
| MCM14524A* | 1024 | Mask-Programmable, -55 to +125°C | 256×4 | 2650# | +3 to +18 | 16 | 620 |
| MCM14524C* | 1024 | Mask Programmable, -40 to +85°C | 256×4 | 3975# | +4.5 to +16 | 16 | 620, 648 |

*Mask-programmable ROMs are manufactured according to a bit-pattern supplied by the customer. A special device number (SCMxxxx) is assigned to each individual pattern. #Measured with $V_{DD} = +5 \text{ V}$, $T_A = 25^\circ \text{C}$

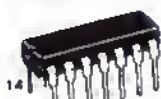




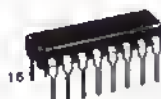
L SUFFIX
CERAMIC PACKAGE
CASE 620



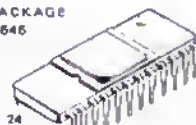
L SUFFIX
CERAMIC PACKAGE
CASE 632



P SUFFIX
PLASTIC PACKAGE
CASE 646



P SUFFIX
PLASTIC PACKAGE
CASE 648



L SUFFIX
CERAMIC PACKAGE
CASE 659



L SUFFIX
CERAMIC PACKAGE
CASE 690



P SUFFIX
PLASTIC PACKAGE
CASE 709

The McMOS series of monolithic integrated logic circuits is designed to provide the system design engineer with a medium-speed integrated circuit family which approaches the ideal in performance. The low power dissipation and flexible power supply requirements of this family of devices greatly simplify power supply design, and the high noise immunity and large fanout capability reduce parts count and simplify printed circuit board layout.

All devices may also be obtained in chip form for the manufacturer of hybrid microcircuits.

FEATURES

- Quiescent Power Dissipation = 10 nW/pkg typical for Gates
- High Noise Immunity = 45% of V_{DD} typical
- Single or Multiple Supply Operation — Positive or Negative
- Fan-out — > 50
- Output Logic Excursion Independent of Fan-out
- Diode Protection on All Inputs

$V_{DD} = 3.0 \text{ Vdc}$ to 18 Vdc , $T_A = -55^\circ\text{C}$ to $+125^\circ\text{C}$ for AL Suffix
 $V_{DD} = 3.0 \text{ Vdc}$ to 16 Vdc , $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$ for CL/CP Suffix

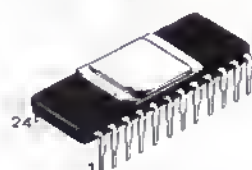
| Function | Type | Case |
|--|---------|---------|
| Dual 3-Input NOR Gate plus Inverter | MC14000 | 632,646 |
| Quad 2-Input NOR Gate | MC14001 | 632,690 |
| Dual 4-Input NOR Gate | MC14002 | 632,686 |
| 18-Bit Static Shift Register | MC14006 | 632,646 |
| Dual Complementary Pair Plus Inverter | MC14007 | 632,646 |
| 4-Bit Carry Adder | MC14008 | 620,648 |
| Quad 2-Input NAND Gate | MC14011 | 632,646 |
| Quad 4-Input NAND Gate | MC14012 | 632,646 |
| Quad Type O Flip-Flop | MC14013 | 632,646 |
| 8-Bit Static Shift Register | MC14014 | 620,648 |
| Dual 4-Bit Static Shift Register | MC14015 | 620,648 |
| Quad Analog Switch/Quad Multiplexer | MC14016 | 632,646 |
| Decade Counter/Divider | MC14017 | 620,648 |
| 10-Bit Binary Counter | MC14020 | 620,648 |
| 8-Bit Static Shift Register | MC14021 | 620,648 |
| Octal Counter/Divider | MC14022 | 620,648 |
| Triple 3-Input NAND Gate | MC14023 | 632,646 |
| Seven Stage Ripple Counter | MC14024 | 632,646 |
| Triple 3-Input NOR Gate | MC14025 | 632,646 |
| Quad J-K Flip-Flop | MC14027 | 620,648 |
| BCD-To-Decimal Decoder/ Binary-To-Octal Decoder | MC14028 | 620,648 |
| Triplet Serial Adder (Positive Logic) | MC14032 | 620,648 |
| 8-Bit Universal Shift Register | MC14034 | 684,709 |
| 4-Bit Parallel-In/Parallel-Out Shift Register | MC14035 | 620,648 |
| Triplet Serial Adder (Negative Logic) | MC14038 | 620,648 |
| 12-Bit Binary Counter | MC14040 | 620,648 |
| Quad Latch | MC14042 | 620,648 |
| Phase Locked Loop | MC14046 | 620,648 |
| Hex Inverter/Buffer | MC14049 | 620,648 |
| Hex Buffer | MC14050 | 620,648 |
| Quad 2-Input OR Gate | MC14071 | 632,646 |
| Quad O-Type Register | MC14076 | 620,648 |
| Quad 2-Input AND Gate | MC14081 | 632,646 |

| Function | Type | Case |
|---|---------|---------|
| Triple Gate 1 Quad 8-Input NAND Gate and 2-Input NOR/OR Gate or 8-Input AND/NAND Gate | MC14501 | 620,648 |
| Strobed Hex Inverter/Buffer | MC14502 | 620,648 |
| 60-Bit Static Random Access Memory | MC14505 | 632,646 |
| Dual Expandable AND OR INVERT Gate | MC14506 | 620,648 |
| Quad Exclusive OR Data | MC14507 | 622,648 |
| Dual 4-Bit Latch | MC14508 | 684,709 |
| BCD Up/Down Counter | MC14510 | 620,648 |
| BCD-To-Seven Segment Latch/Decoder/Driver | MC14511 | 620,648 |
| 5-Channel Data Selector | MC14512 | 620,648 |
| 4-Bit Latch/8 to 16 Line Decoder (High) | MC14514 | 684,709 |
| 4-Bit Latch/4 to 16 Line Decoder (Low) | MC14515 | 684,709 |
| Binary Up/Down Counter | MC14518 | 620,648 |
| Dual 64-Bit Static Shift Register | MC14517 | 620,648 |
| Dual BCD Up Counter | MC14518 | 620,648 |
| 4-Bit AND/OR Selector 10-Input 2-Channel Data Selector or Quad Exclusive NOR Gate | MC14519 | 620,648 |
| Dual Binary Up Counter | MC14520 | 620,648 |
| 24-Stage Frequency Divider | MC14521 | 620,648 |
| Programmable Divide-By-N 4-Bit Counter (BCD) | MC14522 | 620,648 |
| 1024-Bit Read Only Memory | MC14524 | 620,648 |
| Programmable Divide-By-N 8-Bit Counter (Binary) | MC14526 | 620,648 |
| BCD Rate Multiplier | MC14527 | 620,648 |
| Dual Retriggerable/Retriggerable Monostable Multivibrator | MC14528 | 620,648 |
| Dual 4-Channel Analog Data Selector | MC14529 | 620,648 |
| Quad 5-Input Majority Logic Gate | MC14530 | 620,648 |
| 12-Bit Parity Tree | MC14531 | 620,648 |
| 8-Bit Priority Encoder | MC14532 | 620,648 |
| Real Time 5 Decade Counter | MC14538 | 684,709 |
| Programmable Timer | MC14536 | 620,648 |
| 256-Bit Static Random Access Memory | MC14537 | 690 |
| Quad 4-Channel Data Selector/Multiplexer | MC14539 | 620,648 |
| Programmable Oscillator/Timer | MC14541 | 632,646 |
| BCD-To-Seven Segment Latch/Decoder/Driver | MC14543 | 620,648 |
| Successive Approximation Register | MC14549 | 620,648 |
| 256-Bit Static Random Access Memory | MC14552 | 684,709 |
| Ten-Stage DCM Counter | MC14553 | 620,648 |
| 2 x 2-Bit Parallel Binary Multiplier | MC14554 | 620,648 |
| Dual Binary To 1 of 8 Decoder/Demultiplexer | MC14555 | 620,648 |
| Dual Binary To 1 of 4 Decoder/Demultiplexer (Inverting) | MC14556 | 620,648 |
| 1 to 60-Bit Variable Length Shift Register | MC14557 | 620,648 |
| BCD-To-Seven Segment Decoder | MC14558 | 620,648 |
| Successive Approximation Register | MC14559 | 620,648 |
| NBCD Adder | MC14560 | 620,648 |
| 9's Complementer | MC14561 | 622,646 |
| 120-Bit Static Shift Register | MC14562 | 622,646 |
| Inductive Time Base Generator | MC14566 | 620,648 |
| Hex Gate (Quad Inverter Plus 2-Input NOR Data plus 2-Input NAND Gate) | MC14572 | 620,648 |
| 4 x 8 Multiplex Register | MC14580 | 684,709 |
| 4-Bit Automatic Logic Unit | MC14581 | 684,709 |
| Look Ahead Carry Block | MC14582 | 620,648 |
| Dual Shift Register | MC14583 | 620,648 |
| 8-Bit Magnitude Comparator | MC14585 | 620,648 |

MC14400 Series Complementary MOS

The MC14400 Series contains devices whose designs and specifications are tailored towards specific subsystem applications. The MC14400 Series devices are manufactured with the same low power metal gate complementary MOS processing techniques as the MC14000 and MC14500 Series standard product family devices, and as such will exhibit the same inherent characteristics of the technology such as low power dissipation and high noise immunity. The specifications of these subsystem devices are, however, designed to maximize their efficiency in the applications for which they were intended and may not necessarily meet the more universal specifications required of and guaranteed by our standard MC14000 and MC14500 CMOS product family.

To differentiate the new specification policy, the MC14400 Series will have a new set of suffixes. Some devices will have only a package option, either plastic ("P" suffix) or ceramic ("L" suffix). Other devices will have options available for power supply range ("V" or "F" suffix) and operating temperature range ("E" suffix).



L SUFFIX
CERAMIC PACKAGE
CASE 684



L SUFFIX
CERAMIC PACKAGE
CASE 688



L SUFFIX
CERAMIC PACKAGE
CASE 620



P SUFFIX
PLASTIC PACKAGE
CASE 648



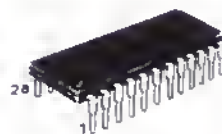
L SUFFIX
CERAMIC PACKAGE
CASE 699



Z SUFFIX
LEADLESS CERAMIC PACKAGE
CASE 703



P SUFFIX
PLASTIC PACKAGE
CASE 704



P SUFFIX
PLASTIC PACKAGE
CASE 709

FUNCTIONS AND CHARACTERISTICS

| Function | Type | V _{DD} Range V _{dc} | Temperature °C | Case |
|--|------------------------|--|-------------------|------------------|
| 2-of-8 Tone Encoder | MC14410L,P | 4.4 to 6.0 | -40 to +85 | 620, 648 |
| 8-bit Rate Generator | MC14411L,P | 5.0 | -40 to +85 | 684, 709 |
| Universal Low Speed (0-600 bps) Modem | MC14412FL | 4.75 to 15 | -40 to +85 | 690 |
| | MC14412VL | 4.75 to 6.0 | -40 to +85 | 690 |
| Quad Precision Timer/Driver | MC14415EFL | 3.0 to 18 | -55 to +125 | 620 |
| | MC14415FL,FP | 3.0 to 16 | -40 to +85 | 620, 648 |
| | MC14415EVL | 3.0 to 6.0 | -55 to +125 | 620 |
| | MC14415VL,VP | 3.0 to 6.0 | -40 to +85 | 620, 648 |
| 2-of-8 Keypad-to-Binary Encoder | MC14419L,P | 3.0 to 6.0 | -40 to +85 | 620, 648 |
| 3½ Digit A/D Logic Subsystem | MC14435EFL | 3.0 to 18 | -55 to +125 | 620 |
| | MC14435FL,FP | 3.0 to 16 | -40 to +85 | 620, 648 |
| | MC14435EVL | 3.0 to 6.0 | -55 to +125 | 620 |
| | MC14435VL,VP | 3.0 to 6.0 | -40 to +85 | 620, 648 |
| L. C. D. Watch/Clock Circuit | MC14440L,Z MCC14440 | 1.4 to 1.85 | -10 to +60 | 699, 703 Chip |
| Oscillator/2 ¹⁶ Divider/Buffer | MC14450L,P | 1.3 to 3.0 | 0 to +50 | 688, 704 |
| | MCC14450 | | | Chip |
| Oscillator/2 ¹¹ to 2 ¹⁹ Divider/Buffered Duty Cycle Control | MC14461L,P | 1.3 to 3.0 | -10 to +60 | 620, 648 |
| | MCC14461 | | | Chip |
| Max Contact Bounce Eliminator | MC14490EFL | 3.0 to 18 | -55 to +125 | 620 |
| | MC14490FL,FP | 3.0 to 16 | -40 to +85 | 620, 648 |
| | MC14490EVL | 3.0 to 6.0 | -55 to +125 | 620 |
| | MC14490VL,VP | 3.0 to 6.0 | -40 to +85 | 620, 648 |



BIPOLAR DIGITAL INTEGRATED CIRCUITS

BIPOLAR DIGITAL INTEGRATED CIRCUITS

Motorola's Bipolar Integrated Circuits include elements of several logic families — MECL, MHTL, MDTL, MRTL and MTTL — from SSI to large scale functions.

Of particular interest is the MECL 10,000 high-speed logic family. This series features significantly lower power dissipation when compared to standard MECL devices. Technological advances have permitted new levels of circuit complexity. One such example is the MCM10149, 1024-Bit PROM.

While not family related, Phase-Locked Loop (PLL) and Megalogic encompass several design approaches to bipolar circuits.

Motorola offers the designer a choice of specifically designed integrated circuits for performing phase-locked loop functions, such as, phase detection, frequency division, filtering, and voltage-controlled signal generation.

Megalogic provides several design approaches to bipolar LSI. Motorola has developed LSI arrays of 160 and 400 gate complexities with typical speeds of 25 ns per gate. These gate arrays keep costly layout and engineering manpower to a minimum.

Motorola's extensive experience in high-reliability military and space programs has resulted in quality assurance for integrated circuits and participation in the MIL-M-3B5 10 Program. The dielectrically isolated MDTL family and the Beam-Lead MTTL family are also used in highly reliable systems.

| | Page |
|--|------|
| MECL MC 10,000 Series | 2-2 |
| MECL III MC1600 Series | 2-4 |
| Megalogic LSI | 2-5 |
| Logic Products for Phase-Locked Loop Applications | 2-6 |
| MHTL MC660 Series | 2-7 |
| MDTL MC830/MC930 Series | 2-8 |
| (Includes MC1B00/MC1900 Series Devices) | |
| MRTL MC700/MCB00/MC900 Series | 2-10 |
| (Includes MC9700/MC9800 Series Devices) | |
| mW MRTL MC70B/MC80B/MC90B Series | 2-11 |
| (Includes MC9700/MC9800 Series Devices) | |
| MTTL Beam Lead Integrated Circuits | 2-12 |
| (MCBC5400 Series) | |
| MTTL Dielectrically Isolated Integrated Circuits | 2-13 |
| (MCE54H00/MCE74H00 Series, MCE5400/MCE7400 Series) | |
| MCE7000 Series Dielectrically Isolated Integrated Circuits | 2-13 |
| MDTL Dielectrically Isolated Integrated Circuits | 2-14 |
| (MCE930 Series) | |
| Special Bipolar Logic Products for Custom Applications | 2-15 |

MECL

MECL 10,000 SERIES INTEGRATED CIRCUITS

MECL

MC10,100/10,200 Series (-30 to +85°C)

MC10,500/10,600 Series (-55 to +125°C)

MECL 10,000 has an excellent speed-power product, has relatively slow rise and fall times, and transmission-line drive capability. The combination of versatile logic functions and the 2.0 ns propagation delay make MECL 10,000 a versatile family for data handling and processing systems.

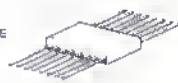
Circuit design with MECL 10,000 is unusually convenient. The differential amplifier input and emitter-follower output permit high fanout, the wired-OR option, and complementary outputs. MECL III is directly compatible with MECL 10,000, and can be used to extend the speed capability of the MECL 10,000 series.



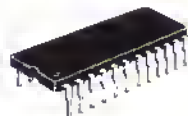
L SUFFIX
CERAMIC PACKAGE
CASE 623



P SUFFIX
PLASTIC PACKAGE
CASE 648



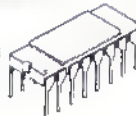
F SUFFIX
CERAMIC PACKAGE
CASE 650



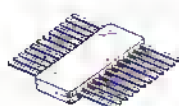
P SUFFIX
PLASTIC PACKAGE
CASE 649



L SUFFIX
CERAMIC PACKAGE
CASE 620



AL SUFFIX
CERAMIC PACKAGE
CASE 690



F SUFFIX
CERAMIC PACKAGE
CASE 652

FUNCTIONS AND CHARACTERISTICS ($V_{CC} = 0$, $V_{EE} = -5.2$ V, $T_A = 25^\circ\text{C}$)

| Function | Type ^① | | Propagation Delay ns typ | Power Dissipation mW typ/pkg* | Case |
|---|-------------------|---------------|--------------------------|-------------------------------|-------------|
| | -30 to +85°C | -55 to +125°C | | | |
| Quad 2-Input NOR Gate With Strobe | MC10100 | — | 2.0 | 100 | 620 |
| Dual OR/NOR Gate | MC10101 | MC10501 | 2.0 | 100 | 620,648,650 |
| Dual 2-Input NDR Gate | MC10102 | MC10502 | 2.0 | 100 | 620,648,650 |
| Quad 2-Input OR Gate | MC10103 | — | 2.0 | 100 | 620 |
| Quad 2-Input AND Gate | MC10104 | MC10504 | 2.7 | 140 | 620,648,650 |
| Triple 2-3-2-Input OR/NOR Gate | MC10105 | MC10505 | 2.0 | 90 | 620,648,650 |
| Triple 4-3-3-Input NOR Gate | MC10106 | MC10506 | 2.0 | 90 | 620,648,650 |
| Triple 2-Input Exclusive OR/Exclusive NOR | MC10107 | MC10507 | 2.5 | 110 | 620,648,650 |
| Dual 4-5-Input OR/NOR Gate | MC10109 | MC10509 | 2.0 | 60 | 620,648,650 |
| Dual 3-Input 3-Output OR Gate | MC10110 | — | 2.4 | 160 | 620,648 |
| Dual 3-Input 3-Output NDR Gate | MC10111 | — | 2.4 | 160 | 620,648 |
| Quad Exclusive OR Gate | MC10113 | — | 2.5 | 175 | 620,648 |
| Triple Line Receiver | MC10114 | MC10514 | 2.4 | 145 | 620,648,650 |
| Dual Line Receiver | MC10115 | MC10515 | 2.0 | 110 | 620,648,650 |
| Triple Line Receiver | MC10116 | MC10516 | 2.0 | 85 | 620,648,650 |
| Dual 2-Wide 2-3-Input OR-AND/OR-AND-INVERT Gate | MC10117 | MC10517 | 2.3 | 100 | 620,648,650 |
| Dual 2-Wide 3-Input OR-AND Gate | MC10118 | MC10518 | 2.3 | 100 | 620,648,650 |
| 4-Wide 4-3-3-Input OR-AND Gate | MC10119 | MC10519 | 2.3 | 100 | 620,648,650 |
| 4-Wide OR-AND/OR-AND-INVERT Gate | MC10121 | MC10521 | 2.3 | 100 | 620,648,650 |
| Triple 4-3-3-Input Bus Driver | MC10123 | — | 3.0 | 310 | 620 |
| Quad MTTL to MECL Translator | MC10124 | MC10524 | 3.5 | 380 | 620,648,650 |
| Quad MECL to MTTL Translator | MC10125 | MC10525 | 4.5 | 380 | 620,648,650 |
| Bus Driver | MC10128 | — | 12.0 | 700 | 620 |
| Quad Bus Receiver | MC10129 | — | 10.0 | 750 | 620 |
| Dual Latch | MC10130 | MC10530 | 2.5 | 155 | 620,648,650 |
| Dual Type D Master-Slave Flip-Flop | MC10131 | MC10531 | $f = 160$ MHz | 235 | 620,648,650 |
| Dual Multiplexer With Latch and Common Reset | MC10132 | — | 3.0 | 225 | 620,648 |
| Quad Latch | MC10133 | MC10533 | 4.0 | 310 | 620,648,650 |
| Multiplexer with Latch | MC10134 | — | 3.0 | 225 | 620,648 |
| Dual J-K Master-Slave Flip-Flop | MC10135 | MC10535 | $f = 140$ MHz | 280 | 620,648,650 |
| Universal Hexadecimal Counter | MC10138 | MC10538 | $f = 150$ MHz | 625 | 620,648,650 |

① L suffix denotes Dual In-Line Ceramic Package, P suffix denotes Dual In-Line Plastic Package, F suffix denotes flat package (i.e., MC10100L = Ceramic Dual In-Line Package, MC10100P = Plastic Dual In-Line Package and MC10500F = Ceramic Flat Package.)

* External Load Power not included.

(continued)

FUNCTIONS AND CHARACTERISTICS (continued)

| Function | Type ① | | Propagation Delay ns typ | Power Dissipation mW typ/pkg* | Case |
|--|--------------|---------------|--------------------------------|-------------------------------------|-------------|
| | -30 to +85°C | -55 to +125°C | | | |
| Universal Decade Counter | MC10137 | MC10537 | f = 150 MHz | 625 | 620,648,650 |
| Bi-Quinary Counter | MC10138 | — | f = 150 MHz | 370 | 620,648 |
| 64-Bit Random Access Memory (90 Ω) | MCM10140 | — | t _{Access} = 15 (max) | 420 | 620,690 |
| Four-Bit Universal Shift Register | MC10141 | MC10541 | f = 200 MHz | 425 | 620,648,650 |
| 64-Bit Random Access Memory (50 Ω) | MCM10142 | — | t _{Access} = 10 (max) | 420 | 620 |
| 8 x 2 Multiplex Register File (RAM) | MCM10143 | — | t _{Access} = 10 | 610 | 623 |
| 256-Bit Random Access Memory | MCM10144 | — | t _{Access} = 30 (max) | 420 | 620,690 |
| 64-Bit Register File (RAM) | MCM10145 | — | t _{Access} = 10 | 625 | 620 |
| 128-Bit Random Access Memory | MCM10147 | — | t _{Access} = 12 (max) | 420 | 620 |
| 64-Bit Random Access Memory (50 Ω) | MCM10148 | — | t _{Access} = 15 (max) | 420 | 620 |
| 1024-Bit Programmable Read-Only Memory | MCM10149 | — | t _{Access} = 25 (max) | — | 690 |
| Quad Latch | MC10153 | — | 4.0 | 315 | 620 |
| Quad 2-Input Multiplexer (Non-Inverting) | MC10152 | — | 2.5 | 197 | 620 |
| Quad 2-Input Multiplexer (Inverting) | MC10152 | — | 2.5 | 218 | 620 |
| 12-Bit Parity Generator-Checker | MC10164 | MC10560 | 5.0 | 320 | 620,648,650 |
| Binary to 1-8 Decoder (Low) | MC10161 | MC10561 | 4.0 | 315 | 620,648,650 |
| Binary to 1-8 Decoder (High) | MC10161 | MC10562 | 4.0 | 315 | 620,648,650 |
| Error Detection-Correction Circuit | MC10161 | — | 5.0 | 520 | 620 |
| 8-Line Multiplexer | MC10168 | MC10564 | 4.0 | 405 | 620,648,650 |
| 8-Input Priority Encoder | MC10165 | — | 4.0 | 575 | 620,648 |
| 8-Bit Magnitude Comparator | MC10165 | — | 4.0 | 405 | 620 |
| Quad Latch | MC10168 | — | 3.0 | 315 | 623 |
| 9 + 2 Bit Parity Generator-Checker | MC10170 | — | 4.0 | 160 | 620 |
| Dual Binary to 1-4 Decoder (Low) | MC10171 | MC10571 | 4.0 | 325 | 620,648,650 |
| Dual Binary to 1-4 Decoder (High) | MC10172 | MC10572 | 4.0 | 325 | 620,648,650 |
| Quad 2-Input Multiplexer/Latch | MC10173 | — | 2.5 | 275 | 620,648 |
| Dual 4 to 1 Multiplexer | MC10174 | MC10574 | 3.5 | 315 | 620,648,650 |
| Quint Latch | MC10175 | MC10575 | 2.5 | 400 | 620,648 |
| Hex "D" Master-Slave Flip-Flop | MC10176 | MC10576 | f = 150 MHz | 405 | 620,648,650 |
| Triple MECL to NMOS Translator | MC10174 | — | — | 1.0 W | 620 |
| Binary Counter | MC10178 | — | f = 150 MHz | 370 | 620,648 |
| Look-Ahead Carry Block | MC10179 | MC10579 | 3.0 (Cn,P) 4.0 (G) | 300 | 620,648,650 |
| Dual High Speed Adder/Subtractor | MC10180 | MC10580 | 4.0 | 360 | 620,648,650 |
| 4-Bit Arithmetic Logic Unit/Function Generator | MC10181 | MC10582 | See Logic Diag. | 600 | 620,648,650 |
| 2-Bit Arithmetic Logic Unit/Function Generator | MC10182 | — | See Logic Diag. | 575 | 620 |
| 4 x 2 Multiplier | MC10183 | — | 50 | 750 | 620 |
| Hex "D" Master Slave Flip-Flop/with Reset | MC10186 | — | f = 150 MHz | 405 | 620 |
| Quad MST to MECL 10,000 Translator | MC10192 | — | 2.5 | 405 | 620 |
| Hex MECL 10,000 to MST Translator | MC10191 | — | 2.2 | 145 | 620 |
| Error Detection-Correction Circuit | MC10195 | — | 2.5 | 520 | 620 |
| Dual Simultaneous Bus Transceiver | MC10191 | — | 2.5 | 405 | 620 |
| Hex Inverter/Buffer | MC10195 | — | 2.5 | 100 | 620 |
| Hex "AND" Gate | MC10197 | — | 2.5 | 275 | 620 |
| High-Speed Dual 3-Input 3-Output OR Gate | MC10210 | — | 1.5 | 160 | 620,648 |
| High-Speed Dual 3-Input 3-Output NOR Gate | MC10210 | — | 4.0 | 405 | 620,648 |
| High-Speed Dual 3-Input 3-Output OR/NOR Gate | MC10212 | — | 4.0 | 405 | 620 |
| High-Speed Triple Line Receiver | MC10216 | MC10616 | 4.9 | 100 | 620,648,650 |
| High-Speed Dual Type D Master-Slave Flip-Flop | MC10231 | MC10631 | f = 225 MHz | 270 | 620,648,650 |
| High Speed 2 x 1 Bit Array Multiplier Block | MC10267 | — | — | 400 | 620 |

① L suffix denotes Dual In-Line Ceramic Package, P suffix denotes Dual In-Line Plastic Package, F suffix denotes Flat package (i.e., MC101D0L = Ceramic Dual In-Line Package, MC10100P = Plastic Quad In-Line Package and MC10500F = Ceramic Flat Package.)

* Load Power not included

MC1600 Series (-30°C to +85°C)

The requirement for digital systems with ever higher performance has increased the need for high-speed integrated circuits. The industry has recognized that the only economical way to obtain high operating system speed is through the use of emitter-coupled logic. Motorola offers a state-of-the-art, emitter-coupled logic family with subnanosecond propagation delays — MECL III.

GENERAL FEATURES

- Gate Switching Speeds of 1.0 ns typical
- Capability of Driving Terminated Lines with Impedance as Low as 50 Ohms
- Flip-Flop Toggle Rate Greater Than 500 MHz
- Operation with Unused Inputs Left Open
- Compatibility with MECL 10,000 Series
- Counting Speeds to above 1 GHz

FUNCTIONS AND CHARACTERISTICS ($V_{CC} = 0$, $V_{EE} = -5.2$ V, $T_A = 25^\circ\text{C}$ unless otherwise noted.)

| Function | Type ① -30° to +85°C | Loading Factor # Each Output | Propagation Delay 50-ohm Load ns typ | Power Dissipation (No Load) mW typ/pkg | Case |
|--|-------------------------|---------------------------------|--|---|-------------|
| High Bandwidth Quad 2-Input OR/NOR Gate | MC1601 | — | 0.76 | 600 | 650 |
| High Bandwidth Triple 2-2-3 Input OR/NOR Gate | MC1602 | — | 0.75 | 460 | 650 |
| High Bandwidth 4-5-Input OR/NOR Gate | MC1603 | — | 0.75 | 320 | 650 |
| High Bandwidth Triple Line Receiver | MC1604 | — | 0.75 | 460 | 650 |
| Dual Type D Master-Slave Flip-Flop | MC1605 | — | 500 MHz typ | 525 | 650 |
| Voltage Controlled Oscillator | MC1648 | — | *225 MHz typ | 150 | 607,632,646 |
| Dual A/D Comparator | MC1650 | 70 | 3.5 | 275 | 620,650 |
| Dual A/D Comparator | MC1651 | 70 | 3.0 | 275 | 620,650 |
| Binary Counter | MC1654 | 70 | *325 MHz typ | 750 \lll | 620 |
| Voltage-Controlled Multivibrator | MC1658 | 70 | *150 MHz typ | 125 | 620,648,650 |
| Dual 4-Input OR/NOR Gate | MC1660 | 70 | 1.1 | 120 | 620,650 |
| Quad 2-Input NOR Gate | MC1662 | 70 | 1.1 | 240 | 620,650 |
| Quad 2-Input OR Gate | MC1664 | 70 | 1.1 | 240 | 620,650 |
| Dual Clocked R-S Flip-Flop | MC1666 | 70 | 1.8 | 220 | 620,650 |
| Dual Clocked Latch | MC1668 | 70 | 1.8 | 220 | 620,650 |
| Master-Slave Type D Flip-Flop | MC1670 | 70 | *350 MHz typ | 220 | 620,650 |
| Triple 2-Input Exclusive OR Gate | MC1672 | 70 | 1.3 | 220 | 620,650 |
| Triple 2-Input Exclusive NOR Gate | MC1674 | 70 | 1.3 | 220 | 620,650 |
| Bi-Duinary Counter | MC1678 | 70 | *350 MHz typ | 750 \lll | 620 |
| Dual 4-5-Input OR/NOR Gate | MC1688 | 70 | 0.8 | 125 | 650 |
| UHF Prescaler Type O Flip-Flop | MC1690 | 70 | *500 MHz min | 200 | 620,650 |
| Quad Line Receiver | MC1692 | 70 | 1.1 | 220 | 620,650 |
| 4-Bit Shift Register | MC1694 | 70 | *325 MHz typ | 750 \lll | 620 |
| 1 GHz Divide-By-Ten Counter | MC1696 | — | *1 GHz min | 650 | 650 |
| Divide-By-Four Gigahertz Counter | MC1699 | — | *1.2 GHz typ | 650 | 650 |

① L suffix denotes Dual In-Line Ceramic Package, F suffix denotes Ceramic Flat Package, P suffix denotes Dual In-Line Plastic Package. (i.e., MC1600L = Ceramic Dual In-Line Package, MC1600F = Ceramic Flat Package, MC1600P = Plastic Dual In-Line Package).

\lll Requires Heat Sink — IERC-LIC-214A2WC or equivalent.

*Toggle Frequency

#DC Loading Factors are based on:

1. Full load output current, $I_L = -25$ mA dc max
2. Maximum input current, $I_{in} = 350$ μ A dc

MEGALOGIC LSI

MEGALOGIC is a bipolar LSI family of low-cost products directed to the computer, industrial, and consumer markets, for both MPU and non-MPU applications. The family will include technologies such as TRL and I²L, plus others that may be applicable. Design techniques will encompass the production-proven gate array technique plus other design approaches to provide the flexibility

required for cost-effective, standard bipolar LSI functions.

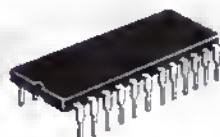
Designers can now implement highly complex systems with only a few basic off-the-shelf LSI components. Benefits include lower system costs, off-the-shelf availability, improved reliability, lower system power drain, fewer parts to assemble and inspect, and more compact system architecture.

BIPOLAR LSI GATE ARRAYS

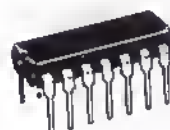
Megalogic encompasses several design approaches to Bipolar LSI. One approach is the basic gate array. The basic arrays with the addition of custom metalization, can be connected quickly and economically into high-density functions of equivalent complexity.

| Characteristic | XC150 | XC400 |
|--------------------------|----------|-----------|
| Number of Gates | 160 | 400 |
| Number of Bonding Pads | 48 | 74 |
| Fan-In | 3 | 3 |
| Fan-Out (Internal) | 5 | 5 |
| Propagation Delay | 25 ns | 25 ns |
| Power Dissipation (Chip) | 480 mW | 1200 mW |
| Logic "0" Level* | 0.5 V | 0.5 V |
| Logic "1" Level* | 2.4 V | 2.4 V |
| Die Size (Mils) | 74 x 103 | 123 x 125 |

*External, at specified load.



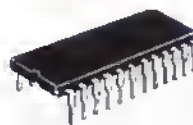
L SUFFIX
CERAMIC PACKAGE
CASE 623



P SUFFIX
PLASTIC PACKAGE
CASE 646



P SUFFIX
PLASTIC PACKAGE
CASE 648



P SUFFIX
PLASTIC PACKAGE
CASE 649

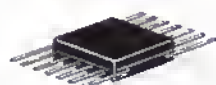
STANDARD PRODUCT LINE

The following standard Bipolar LSI parts have been defined, and are available.

| Device | Function | Case | Applications |
|---------|---|------|---|
| MC8500 | CRCC Generator | 649 | Magnetic tape drive controllers using NRZI recording; 7 or 9 channels. |
| MC8501 | Error Pattern Register | 648 | |
| MC8502 | LRCC/Data Register | 649 | |
| MC8503 | Universal Polynomial Generator (16-Bit) | 646 | Cassette, floppy disc, data communications |
| MC8504 | Universal Presettable Polynomial Generator (4-8bit, Cascadable) | 648 | High-speed disc controllers, digital filtering |
| MC8505 | MOS Dynamic Memory Refresh Logic Circuit | 648 | Add-on memory, memory applications |
| MC8506 | Polynomial Generator (16-Bit) | 648 | Floppy disc, SDLC terminals |
| MC8520 | Deskew/Queue Register | 623 | Magnetic tape drive controllers, phase encoded |
| MC8521* | Data Recovery | T8A | |
| MC8522* | 2-of-8 Tone Decoder (Low Frequency) | T8A | Digital communications, touch tone receivers, telephone networks, mobile radio systems. |
| MC8523* | 2-of-8 Tone Decoder (High Frequency) | T8A | |
| MC8524* | 2-of-8 Tone Decoder Timing and Control | T8A | |

*To be announced.

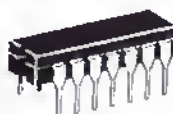
LOGIC PRODUCTS for PHASE-LOCKED LOOP APPLICATIONS



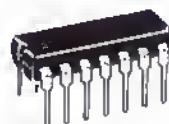
F SUFFIX
CERAMIC PACKAGE
CASE 607



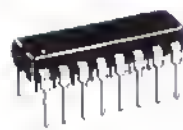
L SUFFIX
CERAMIC PACKAGE
CASE 620



L SUFFIX
CERAMIC PACKAGE
CASE 632



P SUFFIX
PLASTIC PACKAGE
CASE 646



P SUFFIX
PLASTIC PACKAGE
CASE 648

Motorola offers the designer a choice of specially designed integrated circuits for performing phase-locked loop functions: phase detection, frequency division, filtering, and voltage-controlled signal generation. In addition, the choice of circuits permits the designer to select TTL circuits where speed is not critical (<25 MHz), or ECL circuits where high speed is required. The MC12000 series circuits will operate at either +5.0 V or -5.2 V, and translators are included where needed so that all functions are compatible.

FUNCTIONS AND CHARACTERISTICS

| Function | Type | | | | Family | Frequency MHz typ | Power Dissipation mW typ/pkg |
|--|---------------------|---------|---------------------|-------------|--------|----------------------|---------------------------------------|
| | -55 to +125°C | Case | 0 to +75°C | Case | | | |
| Emitter-Coupled Oscillator | — | — | MC1648 | 607,632,646 | MECL | 225 | 150 |
| Voltage-Controlled Multivibrator | — | — | MC1658 | 620,648 | MECL | 150 | 125 |
| Dual Voltage-Controlled Multivibrator | MC4324 | 607,632 | MC4024 | 607,632,646 | MTTL | 30 | 150 |
| Phase-Frequency Detector | MC4344 | 607,632 | MC4044 | 607,632,646 | MTTL | 8.0 | 85 |
| Digital Mixer/Translator | — | — | MC12000 | 632 | MECL | 250 | 470 |
| Two-Modulus Prescaler | — | — | MC12012 | 620 | MECL | 200 | 500 |
| Two-Modulus Prescaler | MC12513 | 620 | MC12013 | 620,648 | MECL | 600 | — |
| Counter Control Logic | — | — | MC12014 | 620 | MTTL | 25 | 25 |
| Offset Control | MC12520 | 632 | MC12020 | 632,646 | MECL | — | — |
| Offset Programmer | MC12521 | 620 | MC12021 | 620,648 | MECL | — | — |
| Phase-Frequency Detector | MC12540 | 632 | MC12040 | 632,648 | MECL | 70 | 425 |
| Crystal Oscillator | MC12560 | 620 | MC12060 | 620,648 | MTTL | 0.1 to 2.0 | 175 |
| Crystal Oscillator | MC12561 | 620 | MC12061 | 620,648 | MTTL | 2.0 to 20 | 210 |
| Programmable Modulo-N Decade Counter (÷0 thru 9) | MC4316 (MC54416) | 620 | MC4016 (MC74416) | 620,648 | MTTL | 8.0 | 250 |
| Programmable Modulo-N Counter (÷0, 1 and ÷0 thru 4) | MC4317 (MC54417) | 620 | MC4017 (MC74417) | 620,648 | MTTL | 8.0 | 250 |
| Programmable Modulo-N Hexadecimal Counter (÷0 thru 15) | MC4318 (MC54418) | 620 | MC4018 (MC74418) | 620,648 | MTTL | 8.0 | 250 |
| Programmable Modulo-N Counter (÷0 thru 3 and ÷0 thru 3) | MC4319 (MC54419) | 620 | MC4019 (MC74419) | 620,648 | MTTL | 8.0 | 250 |

*MC660 Series (-30 to +75°C)

Motorola's MHTL Integrated circuits are especially designed to meet the requirements of industrial applications because of the outstanding noise immunity. MHTL circuits provide error-free operation in high noise environments far beyond the tolerance of other integrated circuit families. Multifunction packages and broad operating temperature range further tailor this device family to the industrial designer's requirements.

*MHTL ceramic dual in-line devices are available with specification over the -55°C to +125°C temperature range and/or with hi-rel processing on special order. See your Motorola representative for pricing.



P SUFFIX
PLASTIC PACKAGE
CASE 875



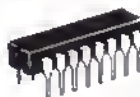
PC SUFFIX
PLASTIC PACKAGE
CASE 676



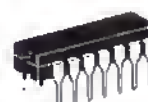
P SUFFIX
PLASTIC PACKAGE
CASE 646



P SUFFIX
PLASTIC PACKAGE
CASE 848



L SUFFIX
CERAMIC PACKAGE
CASE 620



L SUFFIX
CERAMIC PACKAGE
CASE 632

FUNCTIONS AND CHARACTERISTICS ($V_{CC} = 15V = 1.0V_{dc}$, $T_A = 25^\circ C$)

| Function | Type ① -30 to +75°C | Loading Factor Each Output | Propagation Delay ns typ | Power Dissipation mW typ/pkg | Case |
|---|---------------------------|--|--|---------------------------------------|-----------|
| Expandable Dual 4-Input NAND Gate (active pullup) | MC660 | 10 | 110 | 88/26 ② | 632,646 |
| Expandable Dual 4-Input NAND Gate (passive pullup) | MC661 | 10 | 125 | 88/26 ② | 632,646 |
| Expandable Dual 4-Input Line Driver (NAND) | MC662 | 30 | 140 | 180/26 ② | 632,646 |
| Dual J-K Flip-Flop | MC683 | 9 | 3.0 MHz ③ | 200 | 632,646 |
| Mastor Slave RS Flip-Flop | MC664 | 8 | 3.0 MHz ③ | 160 | 632,646 |
| Triple Level Translator | MC665 | MOTL = 8 MTTL III = 5.5 MRTL = 5 | 40 | 83 (MDTL) 104 (MRTL) | 632,646 |
| Triple Level Translator | MC666 | 10 | 75 | 105 | 832,846 |
| Dual Monostable Multivibrator | MC667 | 10 | 140 | 240 | 632,646 |
| Dual 2-Input NAND Gate (passive pullup) | MC668 | 10 | 125 | 176/52 ② | 632,646 |
| Dual 4-Input Expander | MC669 | — | — | — | 632,646 |
| Triple 3-Input NAND Gate (passive pullup) | MC670 | 10 | 125 | 132/39 ② | 632,646 |
| Triple 3-Input NAND Gate (active pullup) | MC671 | 10 | 110 | 132/39 ② | 632,646 |
| Dual 2-Input NAND Gate (active pullup) | MC672 | 10 | 110 | 178/52 ② | 632,646 |
| Dual 2-Input AND-OR-INVERT Gate (active pullup) | MC673 | 10 | 110 | 160/50 ② | 632,646 |
| Dual 2-Input AND-OR-INVERT Gate (passive pullup) | MC674 | 10 | 125 | 160/50 ② | 632,646 |
| Dual Pulse Stretcher | MC675 | 10 | 150 (pins 1,6) 110 (pins 5,6) | 180 | 632,646 |
| BCD-To-Decimal Decoder-Driver | MC676 | — | — | 380 | 620,648 |
| Hex Inverter With Scribe (active pullup) | MC677 | 10 | 110 | 246/96 ② | 620,648 |
| Hex Inverter With Scribe (without output resistors) | MC678 | 10 | 125 | 192/96 ② | 620,648 |
| Dual Lamp/Line Driver | MC679,8 | 126 | 0.6 μs typ | 250/30 ② | 632,646 |
| Hex Inverter (active pullup) | MC680 | 10 | 110 | 246/96 ② | 632,648 |
| Hex Inverter (open collector) | MC681 | 10 | 125 | 192/96 ② | 632,646 |
| Dual Latch | MC682 | 10 | 250 | 375 | 620,848 |
| Dual 2-Input Exclusive OR Gate | MC683 | 10 | — | 380 | 632,646 |
| Decade Counter | MC684 | 10 | 0.5 MHz ③ | 480 | 620,648 |
| Binary Counter | MC685 | 10 | 0.5 MHz ③ | 480 | 620,648 |
| 4-Bit Shift Register | MC686 | 10 | 0.5 MHz ③ | 480 | 620,648 |
| Dual J-K Flip-Flop | MC688 | 10 | 2.5 MHz ③ | 375 | 620,848 |
| Hex Inverter (high voltage) | MC689 | 10 | 150 | 173/55 ② | 632,648 |
| Hex Inverter (active pullup) | MC690 | 10 | 150 | 173/55 ② | 632,648 |
| Hex Inverter/Interface Element | MC691 | 10 | 300 (I ₁ -I) 150 (I ₁ -I) | 500/150 ② | 632,646 |
| Dual Interface Element, Line Driver/Receiver | MC696 | 10 @ 10 V V_{CC} 15 @ 25 V V_{CC} | 760 | 225/60 ② | 620,648 |
| Dual Power AND Gate | MC699 | 10 | 650 (pins 1,6) 350 (pins 1,3) | 850/350 ② | 675,676 ④ |

① L suffix denotes Dual In-Line Ceramic Package, P denotes Dual In-Line Plastic Package (i.e., MC660L = Dual In-Line Ceramic, MC680P = Dual In-Line Plastic Package)

② Inputs High/Inout Low

③ t_{Tog}

④ Case 676 available on special order only.

MC830 Series (0 to +75°C)

MC930 Series (-55 to +125°C)

MAXIMUM RATINGS

| Rating | Value | Unit |
|--|----------------------------|---|
| Supply Voltage — Operating Continuous Pulsed, < 1 second | 4.5 to 5.5 9.0 12 | V _{dc} |
| Output Current (Into Outputs with Outputs Low) Buffers, Power Gates — Continuous Pulsed, < 30 ms All other types — Continuous Pulsed, < 30 ms | 100 300 30 90 | mA _{dc} |
| Input Forward Current — Continuous Pulsed, < 30 ms or Negative Voltage at Input — Continuous Pulsed, < 30 ms | -10 -30 -0.6 -1.6 | mA _{dc} V _{dc} |
| Input Reverse Current or Positive Voltage at Diode Input | 1.0 5.5 | mA _{dc} V _{dc} |
| Operating Temperature Range MC930 Series MC830 Series | -55 to +125 0 to +75 | °C |
| Storage Temperature Range Metal Can, Ceramic Package Plastic Package | -65 to +150 -55 to +125 | °C |
| Maximum Junction Temperature MC930 Series MC830 Series | 175 150 | °C |

MDTL integrated circuits provide an excellent balance of speed, power dissipation, and noise immunity for general purpose digital applications. The line includes many multifunction types. Additional logic power is provided by the "wired OR" capability of the basic MDTL gate.



G SUFFIX
METAL PACKAGE
CASE 603-02
TO-100



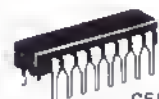
P SUFFIX
PLASTIC PACKAGE
CASE 646



F SUFFIX
CERAMIC PACKAGE
CASE 607



P SUFFIX
CERAMIC PACKAGE
CASE 648



L SUFFIX
CERAMIC PACKAGE
CASE 620



L SUFFIX
CERAMIC PACKAGE
CASE 632
TO-116

FUNCTIONS AND CHARACTERISTICS (V_{CC} = 5.0 V_{dc}, T_A = 25°C)

| Function | Type ① 0 to +75°C | Case | Type ① -55 to +125°C | Case | Loading Factor Each Output | Propaga- tion Delay ns typ | Power Dissipation mW typ/pkg |
|--|-------------------------|-----------------|----------------------------|-------------|-------------------------------------|-------------------------------------|---------------------------------------|
| Expandable Dual 4 Input NAND Gate | MC830 | 607,632,646 | MC930 | 607,632 | 8 | 30 | 22 |
| Expandable Dual 3 2 Input NAND Gate | MC830 | 603 | MC930 | 603 | 8 | 30 | 22 |
| Clocked Flip Flop | MC831 | 603,607,632,648 | MC931 | 603,607,632 | 7 | 40 | 55 |
| Expandable Dual 4 Input Buffer | MC832 | 607,632,646 | MC932 | 607,632 | 25 | 35 | 85 |
| Expandable Dual 3 2 Input Buffer | MC832 | 603 | MC932 | 603 | 25 | 35 | 85 |
| Dual 4 Input Expander | MC833 | 607,632,646 | MC933 | 607,632 | — | — | — |
| Dual 4 3 Input Expander | MC833 | 603 | MC933 | 603 | — | — | — |
| Hex Inverter | MC834 | 607,632,646 | MC934 | 607,632 | 8 | 30 | 66 |
| Hex Inverter (without output resistors) | MC835 | 607,632,646 | MC935 | 607,632 | 8 | 30 | 42 |
| Hex Inverter | MC836 | 607,632,646 | MC936 | 607,632 | 8 | 30 | 66 |
| Hex Inverter | MC837 | 607,632,646 | MC937 | 607,632 | 7 | 25 | 90 |
| Decade Counter | MC838 | 607,632,646 | MC938 | 607,632 | 8 | 30 MHz ③ | 150 |
| Divide by Sixteen Counter | MC839 | 607,632,646 | MC939 | 607,632 | 8 | 30 MHz ③ | 150 |
| Hex Inverter (without input diodes) | MC840 | 607,632,646 | MC940 | 607,632 | 8 | 30 | 66 |
| Hex Inverter (without output resistors and input diodes) | MC841 | 607,632,646 | MC941 | 607,632 | 8 | 30 | 42 |
| 4 Input AND Driver with NOR Strobe | MC843 | 603 | MC943 | 603 | 250 mA | 80 | 50 |
| Expandable Dual 4 Input Power Gate | MC844 | 607,632,646 | MC944 | 607,632 | 27 | 30 | 65 |
| Expandable Dual 3 2 Input Power Gate | MC844 | 603 | MC944 | 603 | 27 | 30 | 65 |
| Clocked Flip Flop | MC845 | 603,607,632,646 | MC945 | 603,607,632 | 12/10 ② | 40 | 60 |
| Quad 2-Input NAND Gate | MC846 | 607,632,646 | MC946 | 607,632 | 8 | 30 | 44 |
| Quad Inverter | MC846 | 603 | MC946 | 603 | 8 | 30 | 44 |
| Quad 2 Input Gate Expander | MC847 | 607,632,646 | MC947 | 607,632 | — | — | — |
| Clocked Flip Flop | MC848 | 603,607,632,646 | MC948 | 603,607,632 | 11/9 ② | 40 | 70 |
| Quad 2 Input NAND Gate (2 k pullup resistor) | MC849 | 607,632,646 | MC949 | 607,632 | 7 | 25 | 66 |
| Quad Inverter (2 k pullup resistor) | MC849 | 603 | MC949 | 603 | 7 | 25 | 60 |

① F suffix denotes Ceramic Flat Package, G suffix denotes Metal Can, L suffix denotes Dual In-Line Ceramic Package, P suffix denotes Dual In-Line Plastic Package. (i.e., MC830G = Metal Can, MC830F = Flat Package, MC830L = Dual In-Line Ceramic Package.)

② Fan-out for MC830 series types/Fan-out for MC930 series types.

③ Maximum counting frequency.

(continued)

MDTL Integrated Circuits (continued)

FUNCTIONS AND CHARACTERISTICS (V_{CC} = 5.0 Vdc, T_A = 25°C) (continued)

| Function | Type ① 0 to +75°C | Case | Type ① -55 to +125°C | Case | Loading Factor Each Output | Propaga- tion Delay ns typ | Power Dissipation mW typ/pkg |
|--|-------------------------|-----------------|----------------------------|-------------|-------------------------------------|-------------------------------------|---------------------------------------|
| Pulse Triggered Binary Monostable Multivibrator | MC850 | 603,607,632,848 | MC950 | 603,607,632 | 10/8 ② | 15 | 50 |
| Dual J-K Flip-Flop (common clock and C _D , separate S _D) | MC851 | 803,607,632,648 | MC951 | 603,607,632 | 10 | 40 | 30 |
| Dual J-K Flip-Flop (separate clock and S _D , no C _D) | MC852 | 607,632,646 | MC952 | 607,632 | 12/10 ② | 40 | 120 |
| Dual J-K Flip-Flop (separate clock and S _D , no C _D) | MC853 | 607,632,646 | MC953 | 607,632 | 12/10 ② | 40 | 120 |
| Dual J-K Flip-Flop (common clock and C _D , separate S _D , 2 k pullup resistor) | MC855 | 607,632,648 | MC955 | 607,632 | 11/9 ② | 40 | 140 |
| Dual J-K Flip-Flop (separate clock and S _D , no C _D , 2 k pullup resistor) | MC856 | 607,632,848 | MC956 | 607,632 | 11/9 ② | 40 | 140 |
| Quad 2-Input Buffer | MC857 | 607,632,646 | MC957 | 607,632 | 25 | 35 | 170 |
| Quad 2-Input NAND Power Gate | MC858 | 607,632,646 | MC958 | 607,632 | 27 | 30 | 130 |
| Expandable Dual 4-Input NAND Gate (2 k pullup resistor) | MC861 | 607,632,646 | MC961 | 607,632 | 7 | 25 | 33 |
| Expandable Dual 3-2 Input NAND Gate (2 k pullup resistor) | MC861 | 603 | MC961 | 603 | 7 | 25 | 33 |
| Triple 3-Input NAND Gate | MC862 | 607,646 | MC962 | 607,632 | 8 | 30 | 33 |
| Dual 2-Input NAND Gate plus Inverter | MC862 | 603 | MC962 | 603 | 8 | 30 | 30 |
| Triple 3-Input NAND Gate (2 k pullup resistor) | MC863 | 607,646 | MC963 | 607,632 | 7 | 25 | 50 |
| Dual 2-Input NAND Gate plus Inverter (2 k pullup resistor) | MC863 | 603 | MC963 | 603 | 7 | 25 | 45 |
| Dual 6-Input NAND Gate | MC1800 | 607,632,646 | MC1900 | 607,632 | 8 | 30 | 22 |
| Dual 5-Input NAND Gate (2 k pullup resistor) | MC1801 | 607,632,646 | MC1901 | 607,632 | 7 | 25 | 33 |
| Expandable 8-Input NAND Gate | MC1802 | 607,632,646 | MC1902 | 607,632 | 8 | 30 | 11 |
| Expandable 8-Input NAND Gate (2 k pullup resistor) | MC1803 | 607,632,646 | MC1903 | 607,632 | 7 | 25 | 16.5 |
| 10-Input NAND Gate | MC1904 | 607,632,646 | MC1904 | 607,632 | 8 | 30 | 97 |
| 10-Input NAND Gate (2 k pullup resistor) | MC1805 | 607,632,646 | MC1905 | 607,632 | 7 | 25 | 16.5 |
| Quad 2-Input AND Gate | MC1806 | 607,632,646 | MC1906 | 607,632 | 8 | 35 | 72 |
| Quad 2-Input AND Gate (2 k pullup resistor) | MC1807 | 607,632,646 | MC1907 | 607,632 | 7 | 30 | 85 |
| Quad 2-Input OR Gate | MC1808 | 607,632,646 | MC1908 | 607,632 | 8 | 35 | 97 |
| Quad 2-Input OR Gate (2 k pullup resistor) | MC1809 | 607,632,646 | MC1909 | 607,632 | 7 | 30 | 115 |
| Quad 2-Input NOR Gate | MC1810 | 607,632,646 | MC1910 | 607,632 | 8 | 30 | 60 |
| Quad 2-Input NOR Gate (2 k pullup resistor) | MC1811 | 607,632,646 | MC1911 | 607,632 | 7 | 25 | 72 |
| Quad 2-Input Exclusive OR Gate | MC1812 | 607,632,646 | MC1912 | 607,632 | 8 | 40 | 120 |
| Quad Latch | MC1813 | 620,648 | MC1913 | 620 | 7 | 35 | 220 |
| Quad Latch | MC1814 | 607,632,646 | MC1914 | 607,632 | 7 | 35 | 220 |
| Parallel Gated Clock Flip-Flop | MC1815 | 607,632,646 | MC1915 | 607,632 | 12/10 ② | 40 | 65 |
| Parallel Gated Clock Flip-Flop | MC1816 | 607,632,646 | MC1916 | 607,632 | 11/9 ② | 40 | 75 |
| Quad 2-Input NAND Gate (without pullup resistor) | MC1818 | 607,632,646 | MC1918 | 607,632 | 8 | 30 | 32 |
| High Voltage Hex Inverter | MC1820 | 632,646 | - | - | 7 | 40 | 42 |

① F suffix denotes Ceramic Flat Package, G suffix denotes Metal Can, L suffix denotes Dual In-Line Ceramic Package, P suffix denotes Dual In-Line Plastic Package, (i.e., MC830G = Metal Can, MC830F = Flat Package, MC830L = Dual In-Line Ceramic Package).

② Pin-out for MC830 series type/Pin-out for MC930 series type

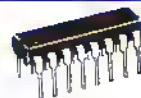
③ Maximum operating frequency.

MC700 series (+15 to +55°C)

MC800 series (0 to +75 and 0 to +100°C)

MC900 series (-55 to +125°C)

Medium-power MRTL integrated circuits provide a broad line of low-cost, multi-function, digital circuits. Typical gate speed is 12 ns, with power dissipation averages of 19 mW (input high) and 5.0 mW (inputs low) per logic node. Devices from the MC700 Series have loading factors normalized for compatibility with the low-power mW MRTL devices for ease in mixing the two power levels in a system.

G SUFFIX
METAL PACKAGE
CASE 601G SUFFIX
METAL PACKAGE
CASE 603 02
TO 100P SUFFIX
PLASTIC PACKAGE
CASE 646F SUFFIX
CERAMIC PACKAGE
CASE 806
TO 91F SUFFIX
CERAMIC PACKAGE
CASE 607P SUFFIX
PLASTIC PACKAGE
CASE 648

FUNCTIONS AND CHARACTERISTICS

(V_{CC} = 3.0 V ± 10% for MC900 Series and MC800F, G Series; 3.6 V ± 10% for MC800P Series and MC700 Series, T_A = 25°C)

| Function | Type ① MC700 Series +15 to +55°C | Case | Type ① MC800 Series 0 to +75°C | Case | Type ① MC800 Series 0 to +100°C | Case | Type ① MC900 Series -55 to +125°C | Case | Loading Factor Each Output | | | Power Dissipation mW typ/pkg | |
|--|--|---------------|--|------|---|----------|---|----------|-------------------------------|--------------------|--------------------------|----------------------------------|-------------------------------------|
| | | | | | | | | | With mW MRTL | With mW MRTL | t _p ns typ | MC700 and MC800P Series | MC800F, G and MC900 Series |
| Buffer | MC700 | 601, 606 | | | MC800 | 601, 606 | MC900 | 601, 606 | 80 | 25 | 20 | 25/50 ② | 16/45 ② |
| Counter Adapter | MC701 | 601 | | | MC801 | 601 | MC901 | 601 | 18 | 5 | 22 | 80 | 55 |
| R-S Flip-Flop | MC702 | 601 | | | MC802 | 601 | MC902 | 601 | 13 | 4 | 14 | 32 | 22 |
| 3-Input NOR Gate | MC703 | 6, 1, 606 | | | MC803 | 601, 606 | MC903 | 601, 606 | 16 | 5 | 12 | 28/7.5 ② | 19/5.0 ② |
| Hall Adder | MC704 | 601, 806 | | | MC804 | 601, 606 | MC904 | 601, 606 | 16 | 5 | 14 | 65 | 45 |
| Hall Shift Register | MC705 | 601, 606 | | | MC805 | 601, 606 | MC905 | 601, 606 | 13 | 4 | 22 | 75 | 53 |
| Hall Shift Register (w/o inverter) | MC706 | 601, 606 | | | MC806 | 601, 606 | MC906 | 601, 606 | 13 | 4 | 22 | 52 | 36 |
| 4-Input NOR Gate | MC707 | 601, 606 | | | MC807 | 601, 606 | MC907 | 601, 606 | 16 | 5 | 12 | 30/7.5 ② | 19/5.0 ② |
| Dual 2-Input NOR Gate | MC714 | 601, 606 | | | MC814 | 601, 606 | MC914 | 601, 606 | 16 | 5 | 12 | 50/15 ② | 38/10 ② |
| Dual 3-Input NOR Gate | MC715 | 603, 606, 646 | MC815 | 640 | MC815 | 603, 606 | MC915 | 603, 606 | 10 | 5 | 12 | 55/15 ② | 38/10 ② |
| J-K Flip-Flop | MC723 | 601, 606, 646 | MC816 | 646 | MC816 | 601, 606 | MC916 | 601, 606 | — | 3 | 30 | 91/79 ③ | 62/54 ③ |
| J-K Flip-Flop | MC724, A | 607, 646 | MC824, A | 646 | MC824 | 607 | MC924 | 607 | 10 | 5 | 12 | 91/79 ③ | — |
| Dual 2-Input NOR Gate | MC725 | 607, 646 | MC825 | 646 | MC825 | 607 | MC925 | 607 | 10 | 5 | 12 | 100/30 ③ | 76/20 ③ |
| Dual 4-Input NOR Gate | MC726 | 603, 606, 646 | MC826 | 646 | MC826 | 603, 606 | MC926 | 603, 606 | 10 | 5 | 35 | 100/15 ③ | 38/10 ③ |
| J-K Flip-Flop | MC727 | 603, 606 | MC827 | 646 | MC827 | 603, 606 | MC927 | 603, 606 | 18 | 5 | 12 | 100/86 ③ | 130/65 ③ |
| Dual Inverter | MC729 | 601, 606 | MC829 | 646 | MC829 | 603, 606 | MC929 | 601, 606 | 10 | 5 | 12 | 87/30 ③ | 76/20 ③ |
| 5-Input NOR Gate | MC731 | 607, 646 | MC831 | 646 | MC831 | 607 | MC931 | 607 | 15 | 5 | 12 | 33/7.5 ② | 19/5.0 ② |
| Dual Exclusive OR Gate | MC732 | 601 | MC832 | 646 | MC832 | 601 | MC932 | 601 | 16 | 5 | 35 | 100/80 ③ | 130/65 ③ |
| J-K Flip-Flop | MC733 | 607, 646 | MC833 | 646 | MC833 | 607 | MC933 | 607 | 10 | 5 | 20 | 120 | 90 |
| Dual Half-Adder | MC734 | 601 | MC834 | 646 | MC834 | 601 | MC934 | 601 | 16 | 5 | 35 | 100/80 ③ | 130/65 ③ |
| Binary Up Counter | MC777 | 646 | MC877 | 646 | MC877 | 607 | MC977 | 607 | 10 | 3 | — | 160 | — |
| 1 J-K Flip-Flop, 1 Expander, 2 Buffers | MC779 | 646 | MC879 | 646 | MC879 | 607 | MC979 | 607 | — | — | — | 141/124 ④ | — |
| Decade Up Counter | MC780 | 646 | MC880 | 646 | MC880 | 607 | MC980 | 607 | 10 | 3 | — | 250 | — |
| Dual Half-Shift Register | MC783 | 607, 646 | MC883 | 646 | MC883 | 607 | MC983 | 607 | 13 | 4 | 22 | 140 | 110 |
| Dual Half-Shift Register (w/inverter) | MC784 | 607, 646 | MC884 | 646 | MC884 | 607 | MC984 | 607 | 13 | 4 | 22 | 100 | 75 |
| Dual 2-Input Expander | MC785, A | 607, 646 | MC885, A | 646 | MC885 | 607 | MC985 | 607 | — | — | 12 | 20/— ⑤ | 17/— ⑤ |
| Dual 4-Input Expander | MC788 | 607, 646 | MC888 | 646 | MC888 | 607 | MC988 | 607 | — | — | 12 | 20/— ⑤ | 17/— ⑤ |
| 1 J-K Flip-Flop, 1 Inverter, 2 Buffers | MC787 | 640 | MC887 | 646 | MC887 | 607 | MC987 | 607 | — | — | — | 138/132 ⑤ | — |
| Dual 3-Input Buffer, non-inverting | MC788 | 607, 646 | MC888 | 646 | MC888 | 607 | MC988 | 607 | 80 | 25 | 24 | 145/56 ⑤ | 128/42 ⑤ |
| Hex Inverter | MC788, A | 607, 646 | MC888, A | 646 | MC888 | 607 | MC988 | 607 | 10 | 5 | 12 | 130/15 ⑤ | 70/20 ⑤ |
| Dual J-K Flip-Flop | MC790 | 607, 646 | MC890 | 646 | MC890 | 607 | MC990 | 607 | 10 | 3 | 35 | 182/158 ⑤ | 124/108 ⑤ |
| Dual J-K Flip-Flop | MC791 | 607, 646 | MC891 | 646 | MC891 | 607 | MC991 | 607 | 16 | 5 | 40 | 130/160 ⑤ | 155/130 ⑤ |
| Triple 3-Input NOR Gate | MC792 | 607, 646 | MC892 | 646 | MC892 | 607 | MC992 | 607 | 19 | 5 | 12 | 82/24 ⑤ | 57/15 ⑤ |
| Serial-Parallel Shift Register | MC794 | 646 | MC894 | 646 | MC894 | 607 | MC994 | 607 | 16 | 5 | 55 | 225 | — |
| Dual Full Adder | MC798 | 607, 646 | MC898 | 646 | MC898 | 607 | MC998 | 607 | 10 | 5 | 60 | 225 | 190 |
| Dual Full Subtractor | MC797 | 607, 646 | MC897 | 646 | MC897 | 607 | MC997 | 607 | 16 | 5 | 60 | 225 | 190 |
| Dual Buffer | MC799 | 603, 606, 646 | MC899 | 646 | MC899 | 603, 606 | MC999 | 603, 606 | 80 | 25 | 15 | 60/90 ② | 32/90 ② |
| Dual 4-Channel Data Selector | MC901 | 646 | MC901 | 646 | MC901 | 607 | MC991 | 607 | 15 | 6 | 26 | 100 | — |
| Dual J-K Flip-Flop | MC9702 | 646 | MC9802 | 646 | MC9802 | 607 | MC992 | 607 | 10 | 3 | 35 | 182/158 ⑤ | — |
| 4-83 Parallel Full Adder | MC9704 | 646 | MC9804 | 646 | MC9804 | 607 | MC994 | 607 | 0 | 2 | 125 | 265 | — |
| Dual 4-Channel Data Distributor | MC9707 | 646 | MC9807 | 646 | MC9807 | 607 | MC997 | 607 | 16 | 6 | 25 | 160 | — |
| Dual Schmitt Trigger | MC9709 | 646 | MC9809 | 646 | MC9809 | 607 | MC999 | 607 | 16 | 6 | 30 | 95 | — |
| Dual 2-Input AND Gate | MC9713 | 646 | MC9813 | 646 | MC9813 | 607 | MC993 | 607 | 16 | 6 | 28 | 100 | — |
| Dual 2-Input NAND Gate | MC9714 | 646 | MC9814 | 646 | MC9814 | 607 | MC994 | 607 | 16 | 6 | 14 | 145 | — |
| Dual 2-Input OR Gate | MC9715 | 646 | MC9815 | 646 | MC9815 | 607 | MC995 | 607 | 16 | 5 | 12 | 180/100 ② | — |
| Hex Expander | MC9719, A | 646 | MC9819, A | 646 | MC9819, A | 607 | MC999 | 607 | — | — | 12 | 13/— ⑤ | — |

*A suffix device have limited capability to drive at least one MTL load or two MTL loads.

① G suffix denotes Metal Can, F suffix denotes Flat Package, P suffix denotes Plastic Package.

② Inputs High/Inputs Low

③ Only Clock Inputs High/Inputs Low

④ Only Clock Input high on flip-flop, other element inputs High/Inputs Low

⑤ Operating Frequency (MHz)

MC708 series (+15 to +55°C)
 MC808 series (0 to +75°C)
 MC908 series (-55 to +125°C)

Low-power mW MRTL integrated circuits are designed for use where minimal system power consumption is desired. Typical gate speed is 27 ns, with typical power dissipation of 6.5 mW (input high) and 0.5 mW (inputs low) per logic node. Devices from the MC708 Series can be mixed with devices from the medium-power MC700 Series which has loading factors normalized for compatibility.



G SUFFIX
METAL PACKAGE
CASE 601



G SUFFIX
METAL PACKAGE
CASE 603
TO-100



P SUFFIX
PLASTIC PACKAGE
CASE 646



F SUFFIX
CERAMIC PACKAGE
CASE 606
TO-91



F SUFFIX
CERAMIC PACKAGE
CASE 607



P SUFFIX
PLASTIC PACKAGE
CASE 648

FUNCTIONS AND CHARACTERISTICS

(V_{CC} = 3.0 V ± 10% for MC908 Series, 3.6 V ± 10% for MC808 Series and MC708 Series; T_A = 25°C)

| Function | Type ① MC708 Series +15 to +55°C | Type ① MC808 Series 0 to +75°C | Case | Type ① MC908 Series -55 to +125°C | Case | Loading Factor Each Output All Series | tp ns typ | Power Dissipation mW typ/pkg | |
|-------------------------------|--|--|-------------|---|---------|--|--------------|--------------------------------------|-----------------|
| | | | | | | | | MC708 Series & MC808 Series | MC908 Series |
| Halt Adder | MC708 | MC808 | 601,606 | MC908 | 601,606 | 4 | 60 | 19/12.5 ② | 14/8.5 ② |
| 2-Input Buffer | MC709 | MC809 | 601,606 | MC909 | 601,606 | 30 | 57 | 7.0/23 ② | 5.5/16 ② |
| Quad 2-Input NOR Gate | MC710 | MC810 | 601,606 | MC910 | 601,606 | 4 | 27 | 10/2.5 ② | 8.0/1.0 ② |
| 4-Input OR/NOR Gate | MC711 | MC811 | 601,606 | MC911 | 601,606 | 4 | 60 | 8.0/5.5 ② | 6.0/3.5 ② |
| Halt Adder | MC712 | MC812 | 601,606 | MC912 | 601,606 | 4 | 66 | 15.5/10.5 ② | 11.5/5.5 ② |
| Type O Flip-Flop | MC713 | MC813 | 601,608 | MC913 | 601,606 | 3 | 75 | 24/17.5 ③ | 17.5/13 ③ |
| Quad 2-Input NOR Gate | MC717 | MC817 | 607,646 | MC917 | 607 | 4 | 27 | 20/5.0 ② | 16/2.5 ② |
| Quad 3-Input NOR Gate | MC718 | MC818 | 603,606,646 | MC918 | 603,606 | 4 | 27 | 12/2.5 ② | 9.5/1.0 ② |
| Quad 4-Input NOR Gate | MC719 | MC819 | 607,646 | MC919 | 607 | 4 | 27 | 13/2.5 ② | 11/1.0 ② |
| J-K Flip-Flop | MC720 | MC820 | 601,606 | MC920 | 601,606 | 2 | 50 | 20.6/14.6 ④ | 15.5/10 ④ |
| Quad 2-Input Gate Expander | MC721 | MC821 | 601,606 | MC921 | 601,606 | — | 27 | 3.0/— ② | 3.0/— ② |
| J-K Flip-Flop | MC722 | MC822 | 603,606,646 | MC922 | 603,606 | 4 | 70 | 24/20 ④ | 17.5/13 ④ |
| 5-Input NOR Gate | MC728 | MC828 | 601,606 | MC928 | 601,606 | 4 | 27 | 7.5/1.0 ② | 6.5/0.5 ② |
| Quad Exclusive OR/NOR Gate | MC764 | MC864 | 646 | — | — | 4 | — | 25 | — |
| Quad Latch | MC767,A | MC867,A | 648 | — | — | 9 | 50 | 110 | — |
| 8CO-To-Decimal Decoder | MC770 | MC870 | 648 | — | — | 7 | 36 | 100/— ② | — |
| Quad J-K Flip-Flop | MC776 | MC876 | 607,646 | MC976 | 607 | 2 | 50 | 41/29 ④ | 31/20 ④ |
| Quad Type D Flip-Flop | MC778 | MC878 | 607,646 | MC978 | 607 | 3 | 60 | 48/35 ④ | 35/26 ④ |
| Quad Buffer | MC781 | MC881 | 601 | MC981 | 601 | 30 | 57 | 14/46 ② | 11/32 ② |
| J-K Flip-Flop | MC782 | MC882 | 601 | MC982 | 601 | 2 | 80 | 23/21 ④ | 15/13 ④ |
| Triple 3-Input NOR Gate | MC793 | MC893 | 607,646 | MC993 | 607 | 4 | 27 | 18/3.5 ② | 14/2.0 ② |
| Quad 2-Input Buffer | MC798 | MC898 | 607,646 | MC998 | 607 | 30 | 57 | 14/46 ② | 11/32 ② |
| Hex Inverter | MC9718 | MC9818 | 646 | — | — | 4 | 27 | 7.0/3.0 ② | — |
| Hex Expander | MC9720 | MC9820 | 646 | — | — | — | 12 | 30/— ② | — |
| Quad 2-Input Expander | MC9721 | MC9821 | 646 | — | — | — | 27 | 20/— ② | — |
| Quad J-K Flip-Flop | MC9722 | MC9822 | 646 | — | — | 4 | 75 | 24/— ④ | — |
| Quad 2-Input AND Gate | MC9723 | MC9823 | 648 | — | — | 4 | 50 | 12 | — |
| Quad 2-Input NAND Gate | MC9724 | MC9824 | 646 | — | — | 4 | 50 | 20/5.0 ② | — |
| Quad 2-Input OR Gate | MC9725 | MC9825 | 646 | — | — | 4 | 50 | —/7.0 ② | — |

"A" suffix devices have insured capability to drive at least one MTTL load or two MOTL loads.

① G suffix denotes Metal Can, F suffix denotes Flat Package, P suffix denotes Plastic Package.

② Inputs High/Inputs Low unless otherwise noted.

③ Direct Set and Direct Clear Low, All other Inputs High/All Inputs Low.

④ Only Clock Input High/All Inputs Low.

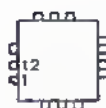
⑤ One Input High/One Input Low.

MCBC5400 Series (-55 to +125°C)

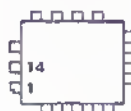


MCBC5400 series integrated circuits comprise a family of transistor-transistor logic designed for general purpose digital applications. The family has a medium operating speed (15-30 MHz clock rate), good external noise immunity, high fan out, and the capability of driving capacitive loads of up to 600 pF.

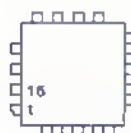
This series is produced using beam lead sealed junction technology. These devices are particularly useful in highly reliable systems using hybrid beam lead assembly techniques.



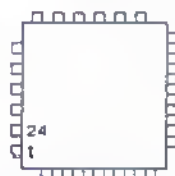
BEAM LEAD CHIP
(12 Lead)
(Geometry Side Down)



BEAM LEAD CHIP
(14 Lead)
(Geometry Side Down)



BEAM LEAD CHIP
(16 Lead)
(Geometry Side Down)



BEAM LEAD CHIP
(24 Lead)
(Geometry Side Down)

MAXIMUM RATINGS

| Rating | Value | Unit |
|-----------------------------|-------------|-----------------|
| Power Supply Voltage | 7.0 | V _{dc} |
| Input Voltage | 5.5 | V _{dc} |
| Operating Temperature Range | -55 to +125 | °C |
| Storage Temperature Range | -65 to +150 | °C |

FUNCTIONS AND CHARACTERISTICS (V_{CC} = 5.0 V, T_A = 25°C)

| Function | Type | Loading Factor Each Output | Propagation Delay ns typ | Power Dissipation mW typ/pkg | Number of Beams |
|--|-------------------------|-------------------------------|-----------------------------|------------------------------------|-----------------|
| | Chip -55°C to +125°C | | | | |
| Quad 2-Input NAND Gate | MCBC5400 | 10 | 10 | 40 | 14 |
| Quad 2-Input NAND Gate (Open Collector Output) | MCBC5401 | 10 | 35 | 40 | 14 |
| Quad 2-Input NOR Gate | MCBC5402 | 10 | 10 | 48 | 16 |
| Hex Inverter | MCBC5404 | 10 | 13 | 60 | 16 |
| Hex Inverter (Open Collector) | MCBC5405 | 10 | 35 | 60 | 16 |
| Triple 3-Input NAND Gate | MCBC5410 | 10 | 10 | 30 | 14 |
| Dual 4-Input NAND Gate | MCBC5420 | 10 | 10 | 20 | 12 |
| 8-Input NAND Gate | MCBC5430 | 10 | 10 | 10 | 12 |
| Dual 4-Input NAND Buffer | MCBC5440 | 30 | 13 | 50 | 14 |
| Expandable Dual 2-Wide 2-Input AND-OR-INVERT Gate | MCBC5450 | 10 | 13 | 28 | 14 |
| Dual 2-Wide 2-Input AND-OR-INVERT Gate | MCBC5451 | 10 | 13 | 28 | 14 |
| Expandable 4-Wide 2-Input AND-OR-Invert Gate | MCBC5453 MCBC5454 | 10 | 13 | 22 | 14 |
| 4-Wide 2-Input AND-OR-Invert Gate | MCBC5454 | 10 | 13 | 22 | 14 |
| Dual 4-Input Expander for AND-OR-INVERT Gate | MCBC5460 | — | 5.0 | 8.0 | 14 |
| J-K Flip-Flop | MCBC5472 | 10 | 30 | 40 | 16 |
| Dual J-K Flip-Flop | MCBC5473 | 10 | 30 | 80 | 24 |
| Dual Type D Flip-Flop | MCBC5479 | 10 | 16 | 84 | 24 |

MTTL

Dielectrically Isolated
INTEGRATED CIRCUITS

MTTL

MCE54H00 Series, MCE5400 Series (-55 to +125°C)
MCE74H00 Series, MCE7400 Series (0 to +70°C)



The Dielectrically Isolated Integrated Circuit (DIIC) MTTL family is designed specifically for use in military and space applications that require a high degree of reliability under severe radiation environments and post irradiation operation. The MTTL DIIC family utilizes nichrome resistors, post metalization passivation, monometallic interconnections, and very small high frequency transistor structures to enhance the radiation resistant qualities of this line.



F SUFFIX
CERAMIC PACKAGE
CASE 607

FUNCTIONS AND CHARACTERISTICS ($V_{CC} = 5.0 \text{ V}$, $T_A = 25^\circ\text{C}$)

| Function | MCE54H00/74H00 Series Type | | Loading Factor Each Output | Propa- gation Delay ns typ | Power Dissipation m/W typ/pkg |
|--|-------------------------------|------------|-------------------------------------|-------------------------------------|--|
| | -55 to +125°C | 0 to +70°C | | | |
| Quad 2-Input NAND Gate | MCE54H00 | MCE74H00 | 10 | 6.0 | 80 |
| Quad 2-Input NAND Gate (Open Collector Output) | MCE54H01 | MCE74H01 | 10 | 8.0 | 80 |
| Hex Inverter | MCE54H04 | MCE74H04 | 10 | 6.0 | 120 |
| Triple 3-Input NAND Gate | MCE54H10 | MCE74H10 | 10 | 6.0 | 60 |
| Dual 4-Input NAND Gate | MCE54H20 | MCE74H20 | 10 | 6.0 | 40 |
| 11-Input NAND Gate | MCE54H31 | MCE74H31 | 10 | 9.0 | 20 |
| Dual 4-Input NAND Power Gate | MCE54H40 | MCE74H40 | 30 | 6.0 | 80 |
| Dual 2-Wide 2-Input AND-OR-INVERT Gate | MCE54H51 | MCE74H51 | 10 | 6.0 | 58 |
| 4-Wide 2-Input AND-OR-INVERT Gate | MCE54H54A | MCE74H54A | 10 | 6.0 | 40 |
| Dual 2-Wide 2-3-Input AND-OR-INVERT Gate | MCE54H56 | MCE74H56 | 10 | 6.0 | 58 |
| 4-Wide 3-3-2-3-Input AND-OR-INVERT Gate | MCE54H57 | MCE74H57 | 10 | 6.0 | 40 |
| Dual Type D Flip-Flop | MCE54H79 | MCE74H79 | 10 | 16 | 140 |
| Binary To One-Of-Eight Line Decoder | MCE54H146 | MCE74H146 | 10 | — | 130 |
| | MCE5400/7400 Series Type | | | | |
| | -55 to +125°C | 0 to +70°C | | | |
| Dual J-K Flip-Flop | MCE54103 | MCE74103 | 10 | 8.0 | 100 |

NETWORKS

Dielectrically Isolated
INTEGRATED CIRCUITS

NETWORKS

MCE7000 SERIES (0° to +100°C)

The MCE7000 series uses a dielectric isolation instead of the usual junction isolation to combat the effects of gamma radiation. Each component is isolated by a high resistance (10^{10} ohms) layer of SiO_2 . Dielectric isolation also lowers inter-component capacitance and improves efficiency.



F SUFFIX
CERAMIC PACKAGE
CASE 606
TO-91



F SUFFIX
CERAMIC PACKAGE
CASE 607

| Function | Type | Power Dissipation mW typ/pkg | Case |
|-------------------------|---------|------------------------------------|------|
| Seven-Diode Array | MCE7003 | — | 607 |
| Diode-Resistor Network | MCE7005 | 20* | 606 |
| Sixteen-Diode Array | MCE7006 | — | 606 |
| Twelve-Resistor Network | MCE7007 | 97 | 607 |

* 100 Ω resistor.

MCE930 Series (-55 to $+125^{\circ}$)

The Dielectrically Isolated MDTL family is intended for use in military and space applications that require a high degree of reliability under severe radiation environments. In addition to dielectric isolation, this family of devices utilizes nichrome resistors throughout. A post-metalization passivation process further enhances the radiation resistance qualities of the family and very small high frequency trans-

sistor structures are used throughout.

Dielectrically Isolated MDTL has the same electrical specifications as the MC930 family and may be used interchangeably with it. This eliminates the need for redesigning existing equipment to gain radiation-resistance and allows the design engineer to utilize a familiar logic type for new systems.

MAXIMUM RATINGS

| Rating | Value | Unit |
|-----------------------------------|-----------------|--------------------|
| Supply Voltage — Continuous | 8.0 | Vdc |
| Pulsed, < 1 second | 12 | |
| Output Current (into outputs) — | | mAdc |
| Buffers, Power Gates — Continuous | 150 | |
| Pulsed, < 30 ms | 300 | |
| All other types | 30 | |
| Input Forward Current | ± 10 | mAdc |
| Input Reverse Current — | | mAdc |
| Buffers, Power Gates | 5.0 | |
| All other types | 1.0 | |
| Operating Temperature Range — | | $^{\circ}\text{C}$ |
| MCE930 Series | -65 to $+125$ | |
| Storage Temperature Range | -65 to $+150$ | $^{\circ}\text{C}$ |



F SUFFIX
CERAMIC PACKAGE
CASE 607
TO-86

FUNCTIONS AND CHARACTERISTICS ($V_{CC} = 5.0$ Vdc, $T_A = 25^{\circ}\text{C}$)

| Function | Type Case 607 -55 to $+125^{\circ}\text{C}$ | Loading Factor Each Output | Power Dissipation mW typ/pkg |
|---|--|-------------------------------------|------------------------------------|
| Expandable Dual 4-Input NAND Gate | MCE930 | 8.0 | 22 |
| Expandable Dual 4-Input Buffer | MCE932 | 25 | 65 |
| Dual 4-Input Expander | MCE933 | — | — |
| Hex Inverter | MCE936 | 8 | 66 |
| Expandable Dual 4-Input NAND Power Gate | MCE944 | 27 | 65 |
| Clocked Flip-Flop | MCE945 | 10 | 60 |
| Quad 2-Input NAND Gate | MCE946 | 8 | 44 |
| Clocked Flip-Flop | MCE948 | 9.0 | 70 |
| Triple 3-Input NAND Gate | MCE962 | 8.0 | 33 |

SPECIAL BIPOLAR LOGIC PRODUCTS

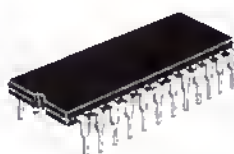
for *CUSTOM* APPLICATIONS



F SUFFIX
CERAMIC PACKAGE
CASE 607



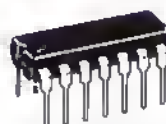
L SUFFIX
CERAMIC PACKAGE
CASE 620



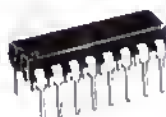
L SUFFIX
CERAMIC PACKAGE
CASE 623



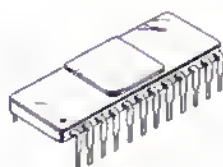
L SUFFIX
CERAMIC PACKAGE
CASE 632



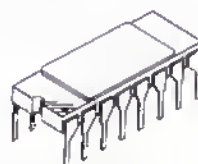
P SUFFIX
PLASTIC PACKAGE
CASE 646



P SUFFIX
PLASTIC PACKAGE
CASE 648



AL SUFFIX
CERAMIC PACKAGE
CASE 684



AL SUFFIX
CERAMIC PACKAGE
CASE 690

(Additional mask-programmable memories are in the MOS device listing.)

| Function | Type | Temperature | Case | Comments |
|--|-------------|---------------|---------------------|--|
| 128-Bit Read Only Memory (Formerly XC170,171) | MCM4000L,P | 0 to +75°C | 620,648 | Bipolar read only memory organized as 16 eight-bit words. Compatible with MDTL and all MTTL lines. Open collectors or 2.0 kilohm pullup resistors at buffered output bit lines. Truth table and output option specified by user. |
| | MCM4300L | -55 to +125°C | 620 | |
| 256-Bit Read Only Memory | MCM4002L,P | 0 to +75°C | 620,648 | Bipolar read only memory organized as 32 eight-bit words. Compatible with MDTL and all MTTL lines. Open collectors or 2.0 kilohm pullup resistors at buffered output bit lines. Truth table and output option specified by user. |
| | MCM4302L | -55 to +125°C | 620 | |
| 512-Bit Read Only Memory | MCM4003AL,L | 0 to +75°C | 684,623 | Bipolar read only memory organized as 64 eight-bit words. Compatible with MDTL and all MTTL lines. Open collector or 2.0 kilohm pullup resistors at buffered output bit lines. Truth table and output option specified by user. |
| | MCM4303AL,L | -55 to +125°C | 684,623 | |
| 1024-Bit Read Only Memory* | MCM4004AL,L | 0 to +70°C | 690,620 | Bipolar read only memory organized as 256 four-bit words. Input loading of -0.25 mA maximum. Typical address time of 50 ns, typical chip select time of 25 ns. Open collector or 2.0 kilohm pullup resistors at output bit lines. Truth table and output option specified by user. |
| | MCM4304AL,L | -55 to +125°C | 690,620 | |
| 512-Bit Programmable Read Only Memory | MCM5003AL,L | 0 to +70°C | 684,623 | Bipolar programmable read only memory organized as 64 eight-bit words. Field programmable by "blowing" appropriate nichrome resistor to break metallization link. Ninth bit available for circuit testing. Open collector outputs. |
| | MCM5303AL,L | -55 to +125°C | 684,623 | |
| 512-Bit Programmable Read Only Memory | MCM5004AL,L | 0 to +70°C | 684,623 | Same as MCM5003AL except 2.0 kilohm pullup resistors on the collector outputs. |
| | MCM5304AL,L | -55 to +125°C | 684,623 | |
| 25 Gata Array | XC177 | -55 to +125°C | 607,632 | Twenty-five gates with two custom layout of metallization required to complete the circuit and obtain the desired function. Compatible with MDTL and all MTTL lines. |
| | | 0 to +75°C | 646,632, 646,648 | |

*Standard options of the MCM4004 are available as MCM4067 and MCM4068 Binary-to-BCD Number Converters and MCM4069 and MCM4070 Hollerith-to-ASCII Converters.



LINEAR INTEGRATED CIRCUITS

LINEAR INTEGRATED CIRCUITS

Linear products include circuits used in consumer, industrial and interface applications. These products are available in a variety of package styles and in chip form. Consumer devices designed principally for entertainment use, i.e., television, audio, radio, automotive, and organ applications.

Industrial products fill important roles in process control, instrumentation, and signal processing functions.

Interface components span the gap between analog information and digital processing. This category is highlighted at Motorola by the number of new monolithic D/A and A/D converters.

TABLE OF CONTENTS

| | Page |
|--|------|
| Interface Circuits | 3-2 |
| Operational Amplifiers (Including Chips) | 3-14 |
| High-Frequency Amplifiers | 3-17 |
| Regulators (Including Chips) | 3-19 |
| Special-Purpose Circuits (Including Chips) | 3-21 |
| Consumer Devices | 3-22 |
| Linear IC Packages | 3-25 |

Chips listed are stock chips. For availability of chips for other products, contact your Motorola sales representative.

INTERFACE CIRCUITS

Interface is the generic term applied to a wide variety of circuit functions which do not conveniently fit into either the Linear (analog) or Digital realms. Often these devices possess both Linear and Digital circuitry and performance parameters. The following pages include applications for Linear Interface Integrated Circuits.

MEMORY INTERFACE

| | |
|---|-----|
| NMDS Memory Interface | 3-3 |
| High capacitance drivers for the ADDRESS, CLOCK or CHIP ENABLE inputs and the sense amplifiers required to configure advanced NMDS memories into effective systems. | |
| Magnetic Memory Interface | 3-5 |
| Drivers and sense amplifiers for core and plated wire memory systems. | |

BUS INTERFACE

| | |
|--|-----|
| Computer, Minicomputer, Microprocessor, Instrumentation Bus Interface | 3-6 |
| Drivers, receivers and transceivers for bus-oriented data systems. Specific devices for IBM computer, popular minicomputer, M6800 microprocessor, and the IEEE instrumentation bus (HP-IB) requirements. | |

INSTRUMENTATION INTERFACE

| | |
|---|-----|
| Numeric Display Interface | 3-8 |
| Driver devices for mating either light-emitting diode (LED) or Gas-Discharge type numeric displays to MOS or Bipolar IC's. | |
| A/D-D/A Conversion | 3-9 |
| Low-cost building block approach IC's pioneered by Motorola. D/A's to 8 bits and two methods of A/D conversion including a simple two chip DVM with a CMDS logic section. | |

COMMUNICATIONS INTERFACE

| | |
|---|------|
| Communications Interface | 3-10 |
| Highlighting a unique monolithic 4 x 4 balanced crosspoint switch which replaces electromechanical devices in PABX or other communications equipment. | |

COMPUTER AND TERMINAL INTERFACE

| | |
|---|------|
| Line Drivers/Receivers | 3-10 |
| Useful in transmitting digital data over long lengths of cable without error or noise problems. Devices meeting the requirements of EIA specifications RS232C, 422 and 423, as well as differential current mode and open collector peripheral drivers are covered. | |
| Comparators | 3-12 |
| A broad line from popular single supply quads to family of quad comparators with Three-State Outputs. | |

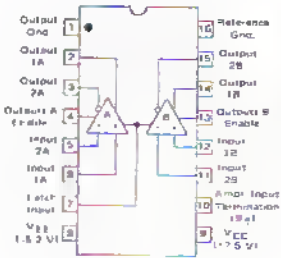
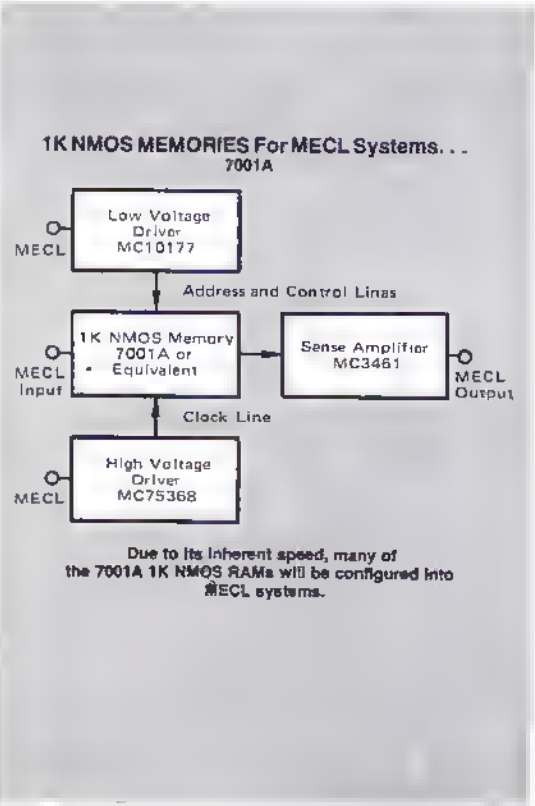
MEMORY INTERFACE

Both NMOS and magnetic memory systems require interface functions.

NMOS Memory

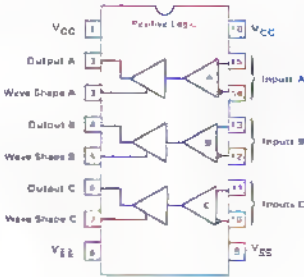
Probably nowhere else has semiconductor technology achieved greater complexities and higher circuit densities in practical, real-world products than in today's advanced NMOS memories. These devices permit greater memory capacity per unit volume and lower costs per bit than imaginable only a few years ago.

However, these memory ICs do not function alone. As an approximate rule of thumb, for each three memory packages in a typical system, one package of support interface circuitry is required. Some memory ICs require only low-voltage ADDRESS and CONTROL line drivers and higher-voltage CLOCK drivers. Other types require a sense amplifier in addition to the drivers.



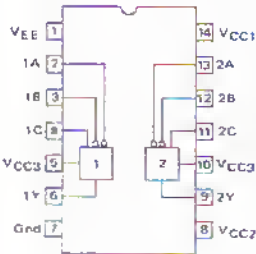
MC3461
0 to 70°C
L Suffix — Case 620
Dual 7001 to MECL
10,000 Sense Amplifier
with latches. No external
components required.

| I_{OL} μA Max | t_{OL} (Amplifier) ns Max | t_{OL} (Enable) ns Max |
|----------------------------|-----------------------------------|--------------------------------|
| ≈ 200 | 10 | 5.0 |



MC10177
-30 to 85°C
L Suffix — Case 620
Triple MECL input
Address Line Driver for
1K or 4K RAMs.

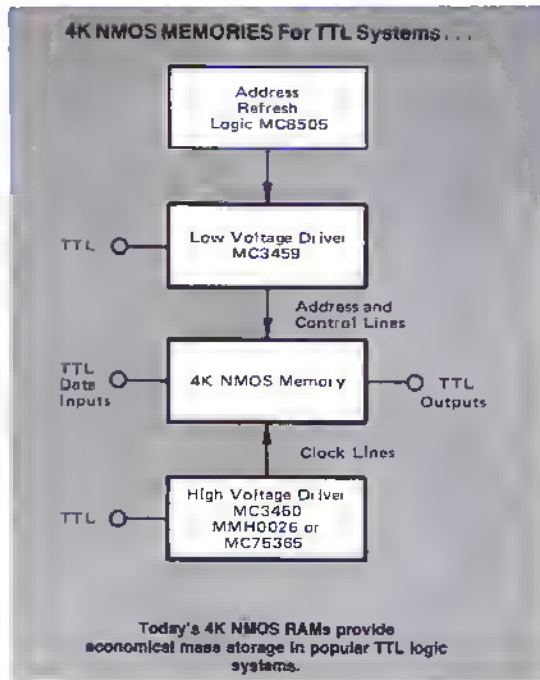
| V_{OL} @ $I_{OL} = 15$ mA Volts Min | V_{OL} @ $I_{OL} = 1.0$ mA Volts Max | t_{OL} @ $C_L = 350$ pF ns Typ |
|---|--|--|
| 4.0 | 0.5 | 8.0 |



MC75368 **MC75358**
0 to 70°C
L Suffix — Case 632
P Suffix — Case 646
CHIP Enable driver with MECL
compatible inputs.
Maximum Supply Voltage = 18V Maximum Supply Voltage = 22 V

| V_{OL} @ $I_{OL} = -100$ μA Volts Min | V_{OL} @ $I_{OL} = 10$ mA Volts Max | t_{OL} @ $C_L = 390$ pF ns Max |
|--|---|--|
| $V_{CC} = 3.0$ | 0.2 | 24 |

INTERFACE (continued)

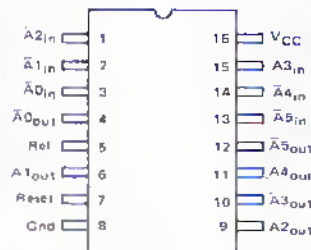


MMH0026
-55 to 125°C
G Suffix — Case 601
L Suffix — Case 632

MMH0020C
0 to 85°C
L Suffix — Case 632
G Suffix — Case 601
P1 Suffix — Case 626

Pin Connections for P1 Package
Drivers for extremely heavy capacitive loading (to 1000 pF).

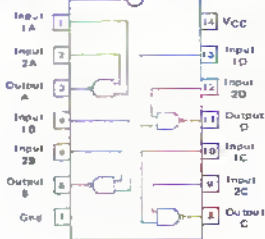
| V_{OH} @ $V_I - V_{IL} = 0.4 V$ Volts Min | V_{OL} @ $V_I - V_{IL} = 2.5 V$ Volts Max | t_{OH} @ $C_L = 1000 pF$ ns Max |
|---|---|---|
| $V_{CC} - 1.0$ | $V_{EE} + 0.5 V$ | 12 |



MC8505
0 to 70°C
L Suffix — Case 620
P Suffix — Case 648

LSI Refresh logic circuit for 4K dynamic RAMs

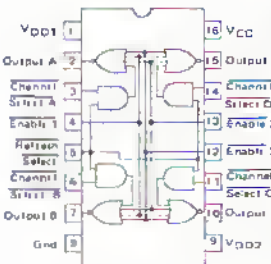
| V_{OH} @ $I_{OH} = -300 \mu A$ Volts Min | V_{OL} @ $I_{OL} = 3.2 mA$ Volts Max | t_{OH} (ADDRESS) ns Max | t_{OH} (REFRESH) ns Max |
|--|--|------------------------------|------------------------------|
| 2.4 | 0.5 | 80 | 145 |



MC3459
0 to 70°C
L Suffix — Case 632
P Suffix — Case 646

Low Voltage (+5 V) Address Line Driver on popular 1K and 4K NMOS RAMs

| V_{OH} @ $I_{OH} = -2.0 mA$ Volts Min | V_{OL} @ $I_{OL} = 60 mA$ Volts Max | t_{OH} @ $C_L = 360 pF$ ns Max |
|---|---|--|
| 2.4 | 0.7 | 26 |

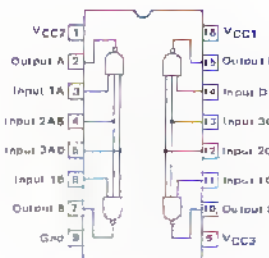


MC3460
Higher voltage (+12 V)
CHIP Enable Driver
Incorporates REFRESH function for 4K RAMs.

MC3465
CHIP Enable Driver
specifically guaranteed for 7001 1K RAMs.

0 to 70°C
L Suffix — Case 620
P Suffix — Case 640

| V_{OH} @ $I_{OH} = -2.0 mA$ Volts Min | V_{OL} @ $I_{OL} = 40 mA$ Volts Max | t_{OH} @ $C_L = 480 pF$ ns Max |
|---|---|--|
| $V_{DD} - 1.0$ | 0.55 | 23 |



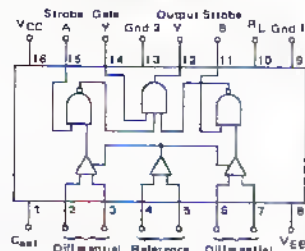
MC75365
0 to 70°C
L Suffix — Case 620
P Suffix — Case 648

CHIP Enable driver for either 4K or 1K RAMs. Differs from MC3460 by not providing REFRESH Input.

| V_{OH} @ $I_{OH} = 100 \mu A$ Volts Min | V_{OL} @ $I_{OL} = 10 mA$ Volts Max | t_{OH} @ $C_L = 200 pF$ ns Max |
|---|---|--|
| $V_{CC} - 0.3$ | 0.3 | 20 |

Magnetic Memory

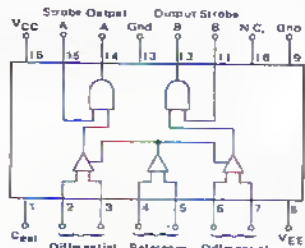
Sense Amplifiers



MC5522
MC5523
-55 to 125°C
L Suffix — Case 620

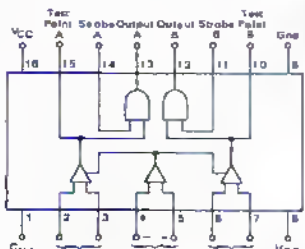
MC7522
MC7523
0 to 70°C
L Suffix — Case 620

Dual channel with open-collector output, high sink current capability



MC5524
MC5525
-55 to 125°C
L Suffix — Case 620

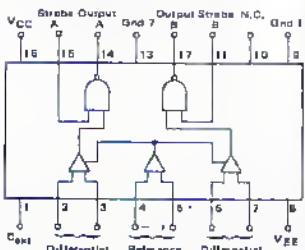
MC7524
MC7525
0 to 70°C
Dual with Independent Strobing
L Suffix — Case 620
P Suffix — Case 648



MC5528
MC5529
-55 to 125°C
L Suffix — Case 620

MC7528
MC7529
0 to 70°C
L Suffix — Case 620
P Suffix — Case 648

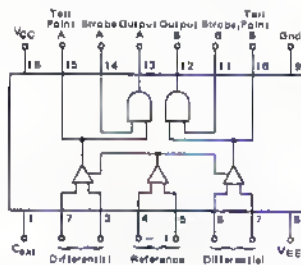
Same as MC7524, 25 except amplifier test points included



MC5534
MC5535
-55 to 125°C
L Suffix — Case 620

MC7534
MC7535
0 to 70°C
L Suffix — Case 620
P Suffix — Case 648

Same as MC7524, 25 except NAND outputs

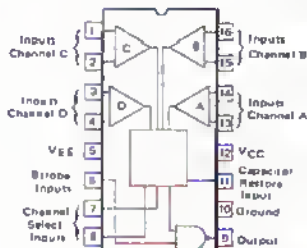


MC5538
MC5539
-55 to 125°C
L Suffix — Case 620

MC7538
MC7539
0 to 70°C
L Suffix — Case 620
P Suffix — Case 648

Same as MC7528, 29 except NAND outputs

| | MC5522 MC5524 MC5528 MC5534 MC5538 | MC5523 MC5525 MC5529 MC5535 MC5539 | MC7522 MC7524 MC7528 MC7534 MC7538 | MC7523 MC7525 MC7529 MC7535 MC7539 |
|------------------------------------|--|--|--|--|
| $V_{TH} @ V_{REF} = 15 \text{ mV}$ | 10 to 20 mV | 8 to 22 mV | 11 to 19 mV | 8 to 22 mV |
| $V_{IH} @ V_{REF} = 40 \text{ mV}$ | 35 to 45 mV | 33 to 47 mV | 36 to 44 mV | 33 to 47 mV |
| Max $I_{IB} =$ | 100 μA | 100 μA | 75 μA | 75 μA |
| Max $t_{PH} @ C_L = 15 \text{ pF}$ | 40 ns | 40 ns | 40 ns | 40 ns |



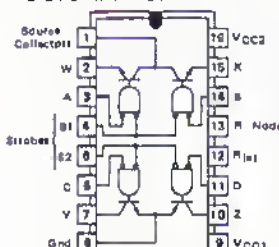
MC1544
-55 to 125°C
L Suffix — Case 620
F Suffix — Case 650

MC1444
0 to 70°C
L Suffix — Case 620

AC-coupled, decoded input channel selection, wired-OR output strobe capability, +5.0 V, -6.0 V power supply.

| Device Number | V_{TH} mV | V_{OH} @ $I_{OH} = -400 \mu\text{A}$ Volts Min | V_{OL} @ $I_{OL} = 10 \text{ mA}$ Volts Max | t_{PH} ns Max |
|---------------|-------------|--|---|-----------------|
| MC1544 | 0.5 to 1.5 | 2.4 | 0.5 | 25 |
| MC1444 | 0.3 to 2.3 | 2.4 | 0.5 | 25 |

Core Driver



MC55325
-55 to 125°C
L Suffix — Case 620
F Suffix — Case 650

MC75325
0 to 70°C
L Suffix — Case 620
P Suffix — Case 648

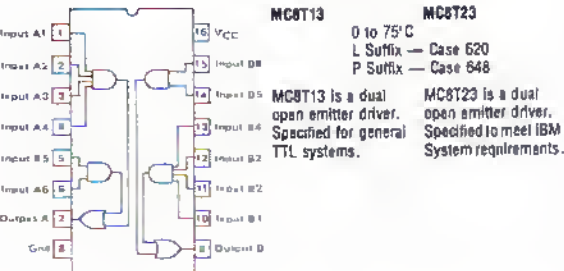
Dual Memory Driver with logic inputs, 24-Volt output capability.

| Device Number | I_{TH} @ $V_{TH} = 600 \text{ mV}$ μA Max | I_{OL} @ $V_{OL} = 24 \text{ V}$ μA Max | t_{PH} (Source) ns Max | t_{PL} (Sink) ns Max |
|---------------|--|--|--------------------------|------------------------|
| MC55325 | 0.70 | 150 | 50 | 45 |
| MC75325 | 0.75 | 200 | 50 | 45 |

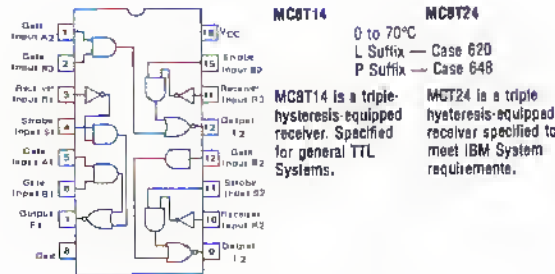
BUS INTERFACE

Several popular bus formats have been established to allow compatibility of equipment regardless of manufacturer.

Computer Bus

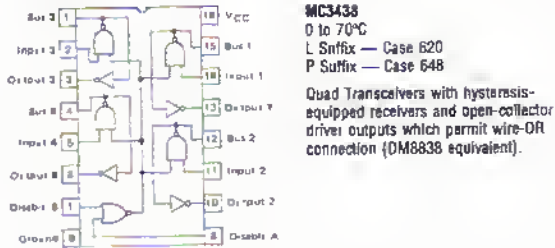


| Device Number | V_{OL} @ $I_{OL} = -75$ mA @ $I_{OL} = -59.3$ mA Volts Max | I_{OS} @ $V_O = 0$ mA Max | C_{in} @ $C_L = 15$ pF ns Max |
|---------------|---|-----------------------------------|---------------------------------------|
| MC8T13 | 2.4 | -30 | 20 |
| MC8T23 | 3.11* | -30 | 20 |

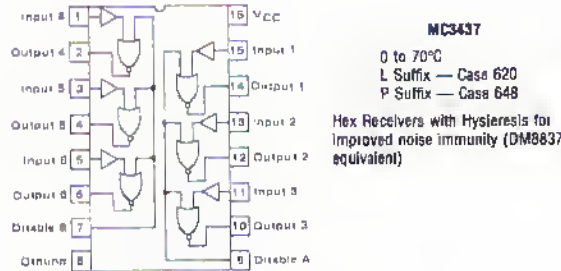


| Device Number | V_{OH} Volts Min | I_{OH} @ $V_{OH} = 3.6$ V @ $V_{OH} = 3.11$ V* mA Max | t_{PHL} @ $C_L = 15$ pF ns Max |
|---------------|-----------------------|--|--|
| MC8T14 | 0.3 | 0.17 | 30 |
| MC8T24 | 0.2 | 0.17* | 30 |

Minicomputer Bus



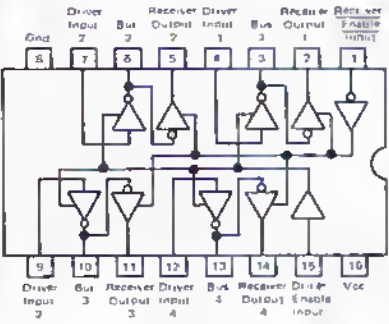
| Receiver Hysteresis Volts Min | V_{OH} @ $I_{OH} = 50$ mA Volts Max | I_{OH} @ $V_{OH} = 4.0$ V μ A Max | t_{PHL} @ $C_L = 15$ pF ns Max | t_{PLH} @ $C_L = 15$ pF ns Max |
|-------------------------------|---|---|--|--|
| 0.25 | 0.7 | 100 | 25 | 30 |



| I_{OH} @ $V_{OH} = 4.0$ V μ A Max | Hysteresis Volts Min | t_{PHL} @ $C_L = 15$ pF ns Max |
|---|----------------------|--|
| 50 | 0.5 | 30 |

Microprocessor Bus

The revolutionary "Computer on a Chip" is another bus organized system. The requirements on the microprocessor bus are especially stringent. Generally, microprocessors (MPUs) are fabricated utilizing MOS technology with its attendant high circuit density characteristics. However, MOS structures become unduly large when it is necessary to conduct large amounts of current. Therefore it is necessary that each of the elements attached to the MPU bus require minimal load current. Most MPU systems can tolerate a total loading equal to only about one conventional TTL load.

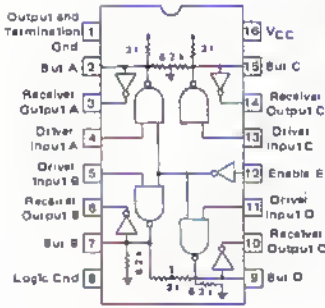


MC6826/MC6880
0 to -75°C
L Suffix — Case 620
P Suffix — Case 648
Quad three-state
bus transceiver

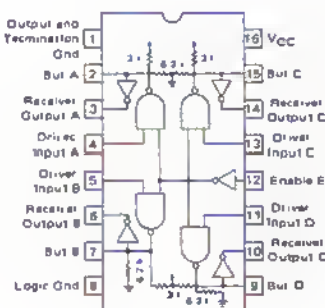
| I_{IH} and I_{IL} Input Current (Either Logic State) μA | I_{OOL} Output Disabled Leakage Current — High Logic State Max μA | t_{PLH} t_{PLL} Propagation Delay Time — High to Low or Low to High ns Max |
|---|--|--|
| 200 | 100 | 17 |

Instrumentation Bus

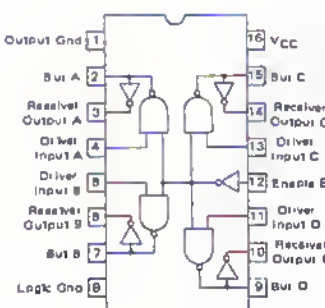
Steps toward standardization of the instrumentation interface bus have been made by the International Electrotechnical Commission (IEC) and the IEEE with Standard 488-1975. Acceptance of these standards will permit interconnection of many types of measurement apparatus, manufactured by numerous firms, into complex systems simply by plugging in connecting cables.



MC3440
0 to 70°C
P Suffix — Case 648
Quad Transistors with 3 Drivers
Sharing a Common Enable Input
 $R_1 = 3.0 k (\text{to } V_{CC})$
 $R_2 = 6.2 k (\text{to Gnd})$



MC3441
0 to 70°C
P Suffix — Case 648
Quad Transistors with all four
drivers controlled by a
Common-Enable Input
 $R_1 = 3.0 k (\text{to } V_{CC})$
 $R_2 = 6.2 k (\text{to Gnd})$



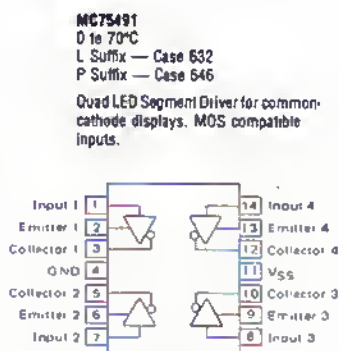
MC3443
0 to 70°C
P Suffix — Case 648
Quad Transistors without
termination resistors. Functional
equivalent to 75138

| Device Number | Receiver Input Hysteresis mV Min | Drive Output Voltage @ $I_{OL} = 48 \text{ mA}$; Volts Max | Bus Drive Voltage Volts | t_{PLH} (Driver or Receiver) ns Max |
|---------------|----------------------------------|---|-------------------------|---------------------------------------|
| MC3440 | 400 | 0.4 | 2.6 to 3.75 | 30 |
| MC3441 | 400 | 0.4 | 2.6 to 3.75 | 30 |
| MC3443 | 400 | 0.4 | — | 25(D); 22(R) |

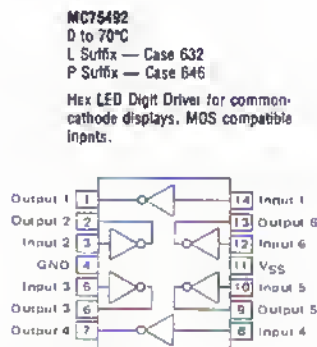
INSTRUMENTATION INTERFACE

Digital techniques are rapidly invading instrumentation systems.

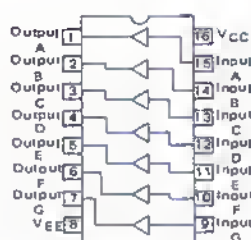
Numeric Display interface



| | | |
|--|--|--------------------------|
| I_1 @ $V_1 = 10\text{ V}$ mA Max | V_{CS} @ $I_{CS} = 50\text{ mA}$ Volts Max | V_{SS} Volts Max |
| 3.3 | 1.2 | 10 |



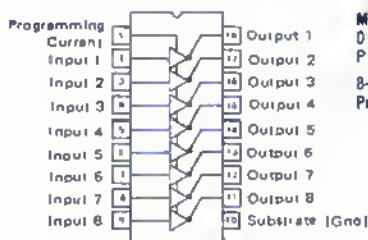
| I_i @ $V_i = 10\text{ V}$ mA Max | V_{OL} @ $I_{OL} = 256\text{ mA}$ Volts Max | V_{OH} Volts Max |
|--|---|--------------------------|
| 3.3 | 1.2 | 10 |



MC3490
0 to 70°C
P Suffix — Case 648

7-Digit Anode Driver with High Logic Level Input Required for Activation

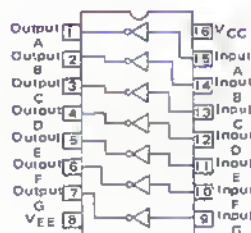
| Breakdown Voltage V _{DS} Min | Input Voltage (OFF-State) V _{IS} Min | Input Voltage (ON-State) V _{IS} Max | Input Current μ A Max |
|---|--|---|---------------------------------|
| 48 | -5.0 | -2.0 | 450 |



MC3491
0 to 70°C
P Suffix — Case 701

8-Segment Cathode Driver with Programmable Current

| Breakdown Voltage Volts Min | Current Deviation (All 8 Outputs) % Max | Output Current Compliance Voltage Volts Range |
|-----------------------------------|--|--|
| 80 | 10 | 5.0 to 50 |



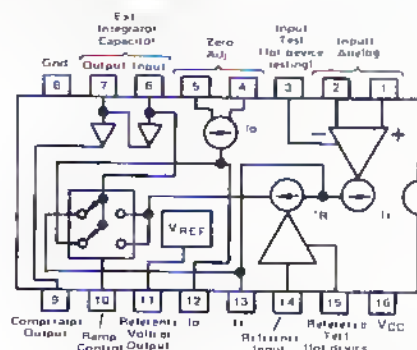
MC3484
0 to 70°C
P Suffix — Case 64B

7-Digit Anode Driver with Low Logic Level Input Required for Activation

| Breakdown Voltage Volts Min | Input Voltage (OFF-State) Volts Max | Input Voltage (ON-State) Volts Min | Input Current μ A Max |
|--------------------------------------|--|---|------------------------------------|
| 48 | -2.0 | -5.0 | -350 |

INTERFACE (continued)

A/D-D/A Conversion

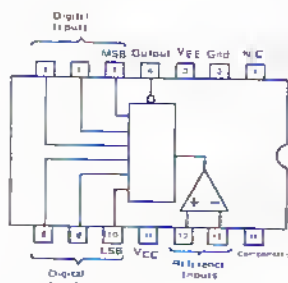


MC1505
-55 to 135°C
L Suffix — Case 620

MC1405
0 to 70°C
L Suffix — Case 620

A dual ramp subsystem which can provide accuracies to 4½ BCD digits or 13 binary bits. May be used with CMOS or TTL logic systems. Mates with MC14435 for complete 3½ BCD Converter function.

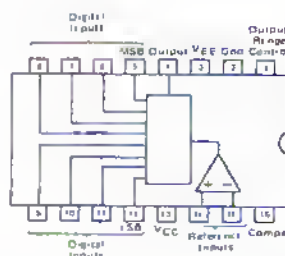
| Linearity Error % Max | Voltage Reference Volts | Temperature Coefficient of Reference %/°C | I _{cc} @ V _{cc} = 5.0 V mA Max |
|-----------------------|-------------------------|---|--|
| ±0.05 | 1.15 to 1.35 | 0.005 | 12 |



MC1506
-55 to 125°C
L Suffix — Case 632

MC1406
0 to 70°C
L Suffix — Case 632

6-Bit Multiplying Digital-to-Analog Converters



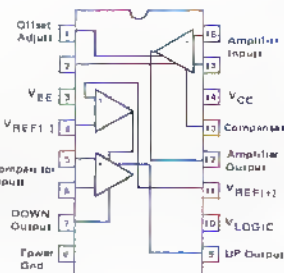
MC1508L8
-55 to 125°C
L Suffix — Case 620

MC1408L8
0 to 70°C
L Suffix — Case 620

8-Bit Multiplying Digital-to-Analog Converters

| Accuracy % Min | I _{max} I _{min} mA Max | Output Current @ V _{cc} = -5.0 V mA Range | P _o @ V _{cc} = -5.0 V mW Max |
|----------------|--|--|--|
| ±0.78 | 50 | 0 to 2.1 | 1.2 |

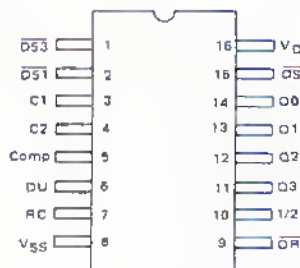
| Device Number | Accuracy % Min | Output Current @ V _{cc} = 2.0 V mA Range | P _o @ V _{cc} = -5.0 V mW Max |
|---------------|----------------|---|--|
| MC1508L8 | ±0.19 | 1.9 to 2.1 | 170 |
| MC1408L8 | ±0.19 | 1.9 to 2.1 | 170 |
| MC1408L7 | ±0.39 | 1.9 to 2.1 | 170 |
| MC1408L6 | ±0.78 | 1.9 to 2.1 | 170 |



MC1507
-55 to 125°C
L Suffix — Case 620

MC1407
0 to 70°C
L Suffix — Case 620

MC1507/MC1407 — Tracking or Successive Approximation A/D Subsystem consisting of a high slew rate operational amplifier and an adjustable dual threshold comparator.



MC14435
-55 to 125°C
MC14435EFL — L-Suffix Case 620
MC14435EVL — L-Suffix Case 620
MC14435FL — L-Suffix Case 620
MC14435FP — P-Suffix Case 648
MC14435VL — L-Suffix Case 620
MC14435VP — P-Suffix Case 648
3½ Digit BCD Subsystem for Mating with the MC1505

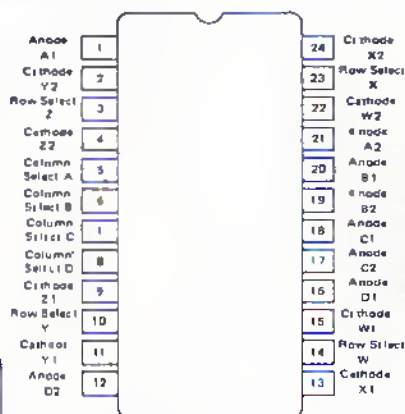
| Device Number | V _{cc} Amplifier mV Max | I _q Amplifier μA Max | Comparator V _{th} @ V _{cc} = 4.0 mV Range | Comparator V _{th} mV Range | Comparator I _q mA Min |
|---------------|----------------------------------|---------------------------------|---|-------------------------------------|----------------------------------|
| MC1507 | 2.0 | 1.5 | ±36 to ±44 | -150 to +320 | 3.2 |
| MC1407 | 6.0 | 2.5 | ±30 to ±50 | -150 to +320 | 3.2 |

| P _{Quiescent} @ V _{cc} = 5.0 V mW Max | I _q @ V _{cc} = 5.0 V (Digital Select) mA Min | I _{cc} @ V _{cc} = 5.0 V (BCD Outputs) mA Min | I _q @ V _{cc} = 5.0 V (All Outputs) mA Min |
|---|--|--|---|
| 1.75 | 1.5 | 1.6 | -0.2 |

COMMUNICATION INTERFACE

Low-cost solid-state crosspoint switches offer important advantages in modern telephone exchanges.

| r_{oe} @ $V_{ce} = 10$ V M Ω Min | r_{oe} @ $I_{Lk} = 20$ mA Ohms Max | BV_{AK} BV_{AK} Volts Min | V_{ce} @ $I_{Lk} = 20$ mA Volts Max |
|---|--|-------------------------------------|---|
| 100 | 10 | 25 | 1.1 |

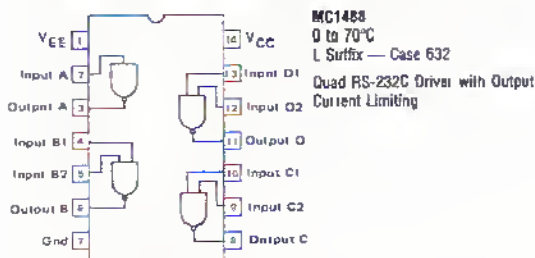


MC3416
0 to 70°C
P Suffix — Case 649
L Suffix — Case 523
4 x 4 two-wire monolithic
Crosspoint Switch for PABX
applications. Select inputs are
both CMOS and TTL compatible.

COMPUTER AND TERMINAL INTERFACE

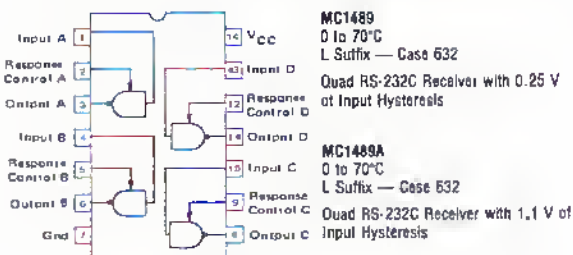
Important interfaces are present in computers and computer terminals.

Drivers and Receivers



MC1488
0 to 70°C
L Suffix — Case 632
Quad RS-232C Driver with Output
Current Limiting

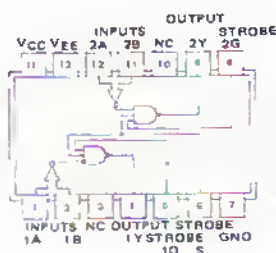
| V_{OH} @ $V_{CC}/V_{EE} = \pm 9.0$ V Volts Min | V_{OL} @ $V_{CC}/V_{EE} = \pm 9.0$ V Volts Max | I_{OH} mA Range | t_{PL} @ $C_L = 15$ pF ns Max |
|--|--|-------------------------|---------------------------------------|
| 6.0 | -6.0 | ± 6.0 to 12 | 175 |



MC1489
0 to 70°C
L Suffix — Case 632
Quad RS-232C Receiver with 0.25 V
of Input Hysteresis

MC1489A
0 to 70°C
L Suffix — Case 632
Quad RS-232C Receiver with 1.1 V of
Input Hysteresis

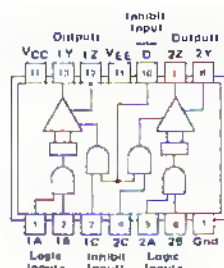
| Device Number | Input V_{OH} Volts Range | Input V_{OL} Volts Range | t_{PL} @ $R_L = 390\Omega$ ns Max |
|------------------|----------------------------------|----------------------------------|---|
| MC1489 | 1.0 to 1.5 | 0.75 to 1.25 | 50 |
| MC1489A | 1.75 to 2.25 | 0.75 to 1.25 | 50 |



MC55107
-55 to 125°C
L Suffix — Case 632
Dual Differential Input Receivers with Active Pull-
up TTL Outputs

MC55108
-55 to 125°C
L Suffix — Case 632
Dual Differential Input Receivers with Open-
Collector Outputs

| Input V_{OH} mV Max | I_{IH} @ $V_{IH} = 0.5$ V μ A Max | I_{IL} @ $V_{IL} = -2.0$ V μ A Max | t_{PL} ns Max |
|-----------------------------|---|--|-----------------------|
| ± 25 | 75 | -10 | 25 |



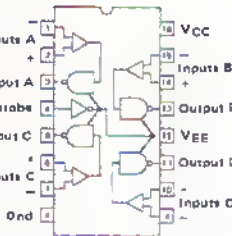
MC75109
0 to 70°C
L Suffix — Case 632
P Suffix — Case 646
Dual Current-Mode Drivers with Inhibit Inputs

MC75110
0 to 70°C
L Suffix — Case 632
P Suffix — Case 646
Dual Current-Mode Drivers with Inhibit Inputs

| Device Number | I_{OH} (ON) mA Max | I_L (OFF) μ A Max | t_{PL} ns Max |
|------------------|----------------------------|-------------------------------|-----------------------|
| MC75109 | 3.5 | 100 | 15 |
| MC75110 | 6.5 | 100 | 15 |

INTERFACE (continued)

DRIVERS AND RECEIVERS (continued)



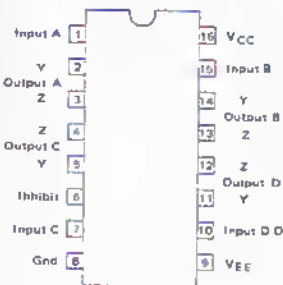
MC3450
0 to 70°C
L Suffix — Case 620
P Suffix — Case 648

MC3452
0 to 70°C
L Suffix — Case 620
P Suffix — Case 648

Quad Differential-Input Receivers

Common Three-State Enable Open Collector Outputs

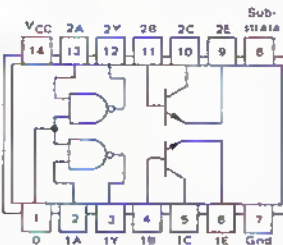
| Input V_{in} mV Max | I_{in} @ $V_{in} = 0.5$ V μ A Max | I_{in} @ $V_{in} = -2.0$ V μ A Max | I_{out} mA Max |
|-----------------------------|---|--|------------------------|
| ± 25 | 75 | -10 | 25 |



MC3453
0 to 70°C
L Suffix — Case 620
P Suffix — Case 648

Quad Current-Mode Drivers with
Common Inhibit Input. Current Sink
Is Approximately 12 mA

| Input V_{in} mV Max | I_{in} @ $V_{in} = 0.5$ V μ A Max | I_{in} @ $V_{in} = -2.0$ V μ A Max | I_{out} mA Max |
|-----------------------------|---|--|------------------------|
| ± 25 | 75 | -10 | 25 |



MC75450
0 to 70°C
L Suffix — Case 632
P Suffix — Case 646

Dual Peripheral Positive AND Driver,
plus two non-committed NPN output
transistors.

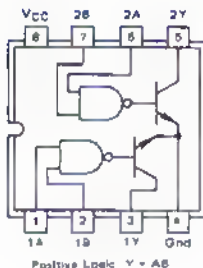
Positive Logic: Y = AB (gate only)
C = AC (gate and transistor)

GATE

| V_{OH} @ $I_{OH} = -400$ μ A Volts Max | V_{OL} @ $I_{OL} = 16$ mA Volts Max | t_{ON} @ $C_L = 15$ pF ns Max |
|--|---|---------------------------------------|
| 2.4 | 0.4 | 14 |

TRANSISTOR

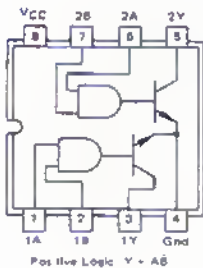
| BV_{CEO} Volts Min | BV_{EBO} Volts Min | h_{FE} @ $V_{CE} = 3.0$ V, $I_C = 300$ mA Min |
|----------------------------|----------------------------|---|
| 35 | 5.0 | 30 |



MC75451
MC75461
0 to 70°C
P Suffix — Case 626
U Suffix — Case 693

Dual Peripheral Positive AND Driver with Logic Gate
Outputs Internally Connected to NPN output
transistors.

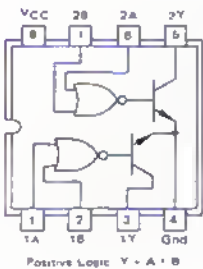
V_{OH} (max) = 30 V — MC75451
= 35 V — MC75461



MC75452
MC75462
0 to 70°C
P Suffix — Case 626
U Suffix — Case 693

Dual Positive NAND Driver with Logic Gate Outputs
Internally Connected to NPN Output Transistors.

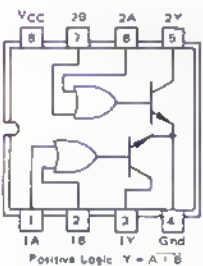
V_{OH} (max) = 30 V — MC75452
= 35 V — MC75462



MC75453
MC75463
0 to 70°C
P Suffix — Case 626
U Suffix — Case 693

Dual Positive OR Driver With Logic Gate Outputs
Internally Connected to NPN Output Transistors.

V_{OH} (max) = 30 V — MC75453
= 35 V — MC75463



MC75454
MC75464
0 to 70°C
P Suffix — Case 626
U Suffix — Case 693

Dual Positive NOR Driver with Logic Gate Output
Internally Connected to NPN Output Transistors

V_{OH} (max) = 30 V — MC75454
= 35 V — MC75464

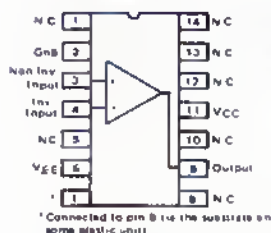
MC75451, MC75452, MC75453, MC75454

| I_{OH} @ $V_{OH} = 30$ V μ A Max | V_{OH} @ $I_{OH} = 300$ mA Volts Max | I_{OL} @ $V_{OL} = 2.4$ V μ A Max | I_{OL} @ $V_{OL} = 0.4$ V mA Max |
|--|--|---|--|
| 100 | 0.7 | 40 | -1.6 |

MC75461, MC75462, MC75463, MC75464

| I_{OH} @ $V_{OH} = 35$ V μ A Max | V_{OH} (After Switching) @ $V_{CE} = 35$ V, $I_C = 300$ mA mV Max |
|--|---|
| 100 | -10 |

Comparators

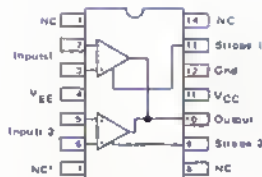


MC1710C
0 to 70°C
G Suffix — Case 601
F Suffix — Case 606
L Suffix — Case 632
P Suffix — Case 646

MC1710
-55 to 125°C
G Suffix — Case 601
F Suffix — Case 606
L Suffix — Case 632
P Suffix — Case 646

Single Comparators

| Device Number | V_{IO} mV Max | I_{IS} μ A Max | A_{VOL} V/V Min |
|---------------|-----------------------|----------------------------|-------------------------|
| MC1710C | 5.0 | 25 | 1000 |
| MC1710 | 2.0 | 20 | 1250 |

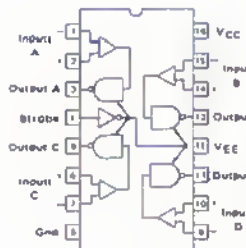


MC1711C
0 to 70°C
G Suffix — Case 603
F Suffix — Case 606
L Suffix — Case 632
P Suffix — Case 646

MC1711
0 to 70°C
G Suffix — Case 603
F Suffix — Case 606
L Suffix — Case 632
P Suffix — Case 646

Dual Comparators with Strobes,
Wire-OR'ed Outputs

| Device Number | V_{IO} mV Max | I_{IS} μ A Max | A_{VOL} V/V Min |
|---------------|-----------------------|----------------------------|-------------------------|
| MC1711C | 5.0 | 100 | 700 |
| MC1711 | 3.5 | 75 | 700 |



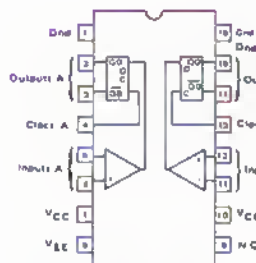
MC3430
MC3431
0 to 70°C
L Suffix — Case 620
P Suffix — Case 646

MC3432
MC3433
0 to 70°C
L Suffix — Case 620
P Suffix — Case 646

Quad High-Speed
Comparators with
Three-State Enable
Common to all Four
Devices

Quad Comparators with
Open Collector Outputs,
Common Strobe Input

| Device Number | V_{IO} mV Max | I_{IS} μ A Max | t_{ON} ns Max |
|---------------|-----------------------|----------------------------|-----------------------|
| MC3430 | ± 6.0 | 20 | 45 |
| MC3431 | ± 10 | 20 | 45 |
| MC3432 | ± 6.0 | 20 | 50 |
| MC3433 | ± 10 | 20 | 50 |



MC1650
MC1651
-30 to 85°C
L Suffix — Case 620
F Suffix — Case 650

Ultra-High Speed Dual Comparators
with Latches

| Device Number | V_{IN} mV Min | Common-Mode Range Volts Min | t_{ON} (Differential Inputs) ns Max | t_{OP} (Clock) ns Max |
|---------------|-----------------------|-----------------------------------|---|-------------------------------|
| MC1650 | ± 20 | -2.5 to 3.0 | 5.0 | 4.7 |
| MC1651 | ± 20 | -3.0 to 2.5 | 5.0 | 4.7 |

COMPARATORS (continued)



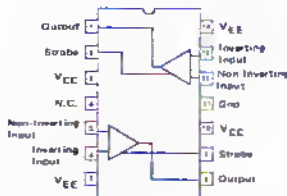
MLM111
-55 to 125°C
G Suffix — Case 601
F Suffix — Case 606
L Suffix — Case 632

MLM211
-25 to 85°C
G Suffix — Case 601
F Suffix — Case 606
L Suffix — Case 632

MLM311
0 to 70°C
G Suffix — Case 601
F Suffix — Case 606
L Suffix — Case 632
P1 Suffix — Case 626

High-Gain, High Input Impedance Comparators. May be used with single power supply. Strobe and balance inputs provided.

| Device Number | V_{OL} mV Max | I_{IS} nA Max | V_{OL} @ $I_{OL} = 50$ mA Volts Max |
|---------------|-----------------------|-----------------------|---|
| MLM111 | 3.0 | 100 | 1.5 |
| MLM211 | 3.0 | 100 | 1.5 |
| MLM311 | 7.5 | 250 | 1.5 |

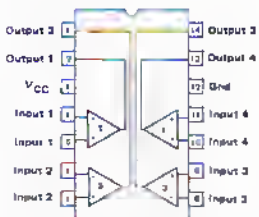


MC1514
-55 to 125°C
F Suffix — Case 607
L Suffix — Case 632

MC1414
0 to 70°C
F Suffix — Case 607
L Suffix — Case 632
P Suffix — Case 645

Dual Comparators with Strobes

| Device Number | V_{OL} mV Max | I_{IS} nA Max | A_{VOL} V/V Min |
|---------------|-----------------------|-----------------------|-------------------------|
| MC1514 | 2.0 | 20 | 1250 |
| MC1414 | 5.0 | 25 | 1000 |



MLM139
MLM139A
-55 to 125°C
L Suffix — Case 632

MLM239
MLM239A
-40 to 85°C
L Suffix — Case 632
P Suffix — Case 646

MLM339
MLM339A
0 to 70°C
L Suffix — Case 632
P Suffix — Case 646

Quad Single Supply Voltage Comparators

| Device Number | V_{OL} @ 25°C mV Max | I_{IS} @ 25°C nA Max | I_{OL} @ $V_{OL} = 500$ mV mA Min | V_{OL} @ $I_{OL} = 2.0$ mA* @ $I_{OL} = 4.0$ mA mV Max |
|---------------|---------------------------------|---------------------------------|--|---|
| MC3302 | 20 | 1000 | ~ | 400* |
| MLM139 | 5.0 | 100 | 6.0 | 500 |
| MLM139A | 2.0 | 100 | 6.0 | 500 |
| MLM239 | 5.0 | 250 | 6.0 | 500 |
| MLM239A | 2.0 | 250 | 6.0 | 500 |
| MLM339 | 5.0 | 250 | 6.0 | 500 |
| MLM339A | 2.0 | 250 | 6.0 | 500 |

Motorola offers a broad line of operational amplifiers to meet a wide range of usages. From low-cost, industry standard types to high precision circuits the span encompasses a large range of performance capabilities.

These linear integrated circuits are available as single, dual, and quad monolithic devices in a variety of package

styles as well as standard and beam-lead chips. The following guide is designed to highlight those Motorola operational amplifiers which are recommended for new designs due to their excellent performance, lower relative cost and ready availability.

NON COMPENSATED — Gain and Frequency-Response characteristics may be optimized for specific applications through the selective addition of external compensating capacitors and resistors.

AN INDUSTRY STANDARD — MC1709

| | | |
|--|---|---|
| <p>This design was among the first high-performance types on the market and still is one of the most popular. Its long history has made it among the most widely sourced unit in the industry, and the most universally available amplifier. In the largest selection of packages, at the lowest cost.</p> | <p>Available Variations:</p> <p>Prime Device — MC1709 $T_A = -55$ to $+125^{\circ}\text{C}$</p> <p>Relaxed Spec. — MC1709C $T_A = 0$ to $+70^{\circ}\text{C}$</p> <p>Military Processed Devices Available — MC1709A</p> <p>Beam Lead — MCB1709</p> <p>Duals —</p> <p>Prime Device — MC1537 Relaxed Spec. — MC1437</p> | <p>Chips:</p> <p>Standard — MCC1709 MCC1709C</p> <p>Beam Lead — MCBC1709</p> <p>Flip-Chip — MCCF1709 MCCF1709C</p> |
|--|---|---|

FOR HIGHER PERFORMANCE GENERAL-PURPOSE APPLICATIONS

| | | |
|--|--|--|
| <p>MC1748</p> <p>Improved version of MC1709, available at a slightly higher price. Has greater gain and slew rate, better input and output impedances and somewhat lower power dissipation.</p> | <p>Available Variations:</p> <p>Prime Device — MC1748 $T_A = -55$ to $+125^{\circ}\text{C}$</p> <p>Relaxed Spec. — MC1748C $T_A = 0$ to $+75^{\circ}\text{C}$</p> | <p>Chips:</p> <p>Standard — MCC1748 MCC1748C</p> <p>Beam Lead — MCBC1748</p> |
| <p>MC1539</p> <p>High slew rate amplifier. Also offers substantial improvement in offset current and voltage, and in frequency response. Recommended for high-performance applications at low cost.</p> | <p>Available Variations:</p> <p>Prime Device — MC1539 $T_A = -55$ to $+125^{\circ}\text{C}$</p> <p>Relaxed Spec. — MC1439 $T_A = 0$ to $+75^{\circ}\text{C}$</p> | <p>Chips:</p> <p>Standard — MCC1539 MCC1439</p> |

FOR SPECIAL APPLICATIONS

| | |
|--|--|
| <p>MC1520 — Differential Output</p> <p>Wide-Band Amplifier, recommended primarily for those applications where differential output is an essential circuit requirement.</p> | <p>Available Variations:</p> <p>Prime Device — MC1520 $T_A = -55$ to $+125^{\circ}\text{C}$</p> <p>Relaxed Spec. — MC1420 $T_A = 0$ to $+75^{\circ}\text{C}$</p> |
| <p>MLM101A — Low Bias Current</p> <p>High-performance amplifier, featuring exceptionally low input bias and offset currents. Limited temperature version (MLM301A) is particularly attractive as general-purpose amplifier due to low cost.</p> | <p>Available Variations:</p> <p>Prime Device — MLM101A $T_A = -55$ to $+125^{\circ}\text{C}$</p> <p>Intermediate Spec. — MLM201A $T_A = -25$ to $+85^{\circ}\text{C}$</p> <p>Relaxed Spec. — MLM301A $T_A = 0$ to $+75^{\circ}\text{C}$</p> <p>Military Qualification or Process Devices Available — MLM101A</p> |

ELECTRICAL SPECIFICATIONS — (Prime Devices)

| Device Type | I _{IB} μA Max | V _{IO} mV Max | I _O nA Max | A _{vol} V/V Min | f _c MHz Typ | BW _p kHz Typ | SR V/μs Typ | Case |
|-------------|------------------------------|------------------------------|-----------------------------|--------------------------------|------------------------------|-------------------------------|-------------------|--------------------|
| MC1709 | 0.5 | 5.0 | 200 | 25 k | 0.5 | 4.0 | 0.25 | 601, 606, 632, 693 |
| MC1748 | 0.5 | 5.0 | 200 | 50 k | 1.0 | 10 | 0.8 | 601, 606 |
| MC1539 | 0.5 | 3.0 | 60 | 50 k | 2.0 | 60 | 4.2 | 601, 632, 693 |
| MC1520 | 2.0 | 10 | 100 | 1 k | 10 | 150 | 5.0 | 602A, 606 |
| MLM101A | 0.075 | 2.0 | 10 | 50 k | 1.0 | 10 | 0.5 | 601, 693 |

COMPENSATED — Internal frequency compensation adjusts roll-off to provide stable operation regardless of amount of feedback employed.

FOR GENERAL-PURPOSE APPLICATIONS

MC1741 — An Industry Standard

High-performance amplifier whose wide availability and low-cost (relaxed specification MC1741C) have made it a popular device for general-purpose amplifier applications.

Available Variations:

| | |
|--|---------|
| Prime Device — | MC1741 |
| $T_A = -55$ to $+125^\circ\text{C}$ | |
| Relaxed Spec. — | MC1741C |
| $T_A = 0$ to $+75^\circ\text{C}$ | |
| Military Qualification or Process Devices Available — | MC1741 |
| Duals — | |
| Prime Device — | MC1747 |
| | MC1558 |
| Intermediate Spec. — | MC1458 |
| Relaxed Spec. — | MC1747C |
| | MC1458C |

Chips:

| | |
|-----------|-----------|
| Standard | MCC1741 |
| | MCC1741C |
| Beam Lead | MCBC1741 |
| Flip-Chip | MCCF1741 |
| | MCCF1741C |
| | MCCF1558 |
| | MCCF1458 |

MC1741S — High Slew Rate

Performance similar to MC1741 except with slew rate and power bandwidth to 20 times higher. Low cost "C" version is ideal for applications where restricted temperature range is suitable.

Available Variations:

| | |
|-------------------------------------|----------|
| Prime Device — | MC1741S |
| $T_A = -55$ to $+125^\circ\text{C}$ | |
| Relaxed Spec. — | MC1741SC |
| $T_A = 0$ to $+75^\circ\text{C}$ | |

MLM107 — Low Input Current

Designed for applications such as sample-and-hold circuits and long interval integrators, where improved input characteristics are needed.

Available Variations:

| | |
|-------------------------------------|--------|
| Prime Device — | MLM107 |
| $T_A = -55$ to $+125^\circ\text{C}$ | |
| Intermediate Spec. — | MLM207 |
| $T_A = -25$ to $+85^\circ\text{C}$ | |
| Relaxed Spec. — | MLM307 |
| $T_A = 0$ to $+70^\circ\text{C}$ | |

MC1556 — High Input Impedance

High performance amplifier featuring extremely high input impedance, high gain and a general upgrading of all other characteristics that make this device particularly suited for the most demanding overall amplifier needs.

Available Variations:

| | |
|-------------------------------------|---------|
| Prime Device — | MC1556 |
| $T_A = -55$ to $+125^\circ\text{C}$ | |
| Relaxed Spec. — | MC1456 |
| $T_A = 0$ to $+70^\circ\text{C}$ | MC1456C |

MC1776 — Micropower Programmable

Programmable, by means of external resistor, to optimize current, voltage and noise characteristics. Operates over ± 1.2 to ± 18 Volt power supply range, with microwatt power dissipation at the lower supply voltages.

Available Variations:

| | |
|-------------------------------------|---------|
| Prime Device — | MC1776 |
| $T_A = -55$ to $+125^\circ\text{C}$ | |
| Relaxed Spec. — | MC1776C |
| $T_A = 0$ to $+70^\circ\text{C}$ | |
| Low Cost Version — | MC3476 |
| $T_A = 0$ to $+70^\circ\text{C}$ | |

MLM110 — Unity Gain Follower

For voltage follower purposes in highly critical instrumentation applications.

Available Variations:

| | |
|-------------------------------------|--------|
| Prime Device — | MLM110 |
| $T_A = -55$ to $+125^\circ\text{C}$ | |
| Intermediate Spec. — | MLM210 |
| $T_A = -25$ to $+85^\circ\text{C}$ | |
| Relaxed Spec. — | MLM310 |
| $T_A = 0$ to $+70^\circ\text{C}$ | |

MC1536 — High Output Voltage

High gain amplifier with maximum supply voltage to ± 40 volts, for extremely wide output voltage swing.

Available Variations:

| | |
|-------------------------------------|---------|
| Prime Device — | MC1536 |
| $T_A = -55$ to $+125^\circ\text{C}$ | |
| Relaxed Spec. — | MC1436 |
| $T_A = 0$ to $+75^\circ\text{C}$ | MC1436C |
| Chips: | |
| Standard — | MCC1536 |
| | MCC1436 |

MC1538 — Power Booster

Designed as high current gain amplifiers, with unity voltage gain. Can deliver load currents to ± 300 mA, for driving low impedance loads.

Available Variations:

| | |
|-------------------------------------|--------|
| Prime Device — | MC1538 |
| $T_A = -55$ to $+125^\circ\text{C}$ | |
| Relaxed Spec. — | MC1438 |
| $T_A = 0$ to $+75^\circ\text{C}$ | |

ELECTRICAL SPECIFICATIONS — (Prime Devices)

| Device Type | I_{IB} μA Max | V_{IO} mV Max | I_{IO} nA Max | A_{VOL} V/V Min | f_c MHz Typ | BW _p kHz Typ | SR V/ μs Typ | Case |
|-------------|----------------------------------|-----------------------|-----------------------|-------------------------|---------------------|-------------------------------|-------------------------------|--------------------|
| MC1741 | 0.5 | 5.0 | 200 | 50 k | 1.0 | 10 | 0.8 | 601, 606, 632, 693 |
| MC1741S | 0.5 | 5.0 | 200 | 50 k | 1.0 | 200 | 15 | 601, 693 |
| MLM107 | 0.075 | 2.0 | 10 | 50 k | 1.0 | 10 | 0.5 | 601 |
| MC1556 | 0.015 | 4.0 | 2.0 | 100 k | 1.0 | 40 | 2.5 | 601, 632, 693 |
| MC1776 | 0.0075 | 5.0 | 3.0 | 200 k | 0.2 | 1.5 | 0.1 | 601 |
| MLM110 | 0.003 | 4.0 | — | Unity | 20 | 300 | 30 | 601, 693 |
| MC1536 | 0.02 | 5.0 | 3.0 | 100 k | 1.0 | 23 | 2.0 | 601, 693 |
| MC1538 | 200 | — | — | 900 | — | 1500 | 75 | 614 |

MULTIPLE OPERATIONAL AMPLIFIERS

Qual and Quad operational amplifiers for space and cost savings in applications requiring more than one amplifier.

DUAL OPERATIONAL AMPLIFIERS

MC1537 — NON COMPENSATED

Dual equivalent of the highly popular MC1709.

Available Variations:

Prime Device — MC1537
 $T_A = -55$ to $+125^{\circ}\text{C}$
 Relaxed Spec. — MC1437
 $T_A = 0$ to $+75^{\circ}\text{C}$

MC1558, MC1747 — COMPENSATED

Dual equivalents of the highly popular MC1741. The two devices and their "variations" differ principally in pin configurations.

Available Variations:

Prime Device — MC1558
 $T_A = -55$ to $+125^{\circ}\text{C}$
 Relaxed Spec. — MC1458
 $T_A = 0$ to $+75^{\circ}\text{C}$ MC1458C
 Chips:
 Standard — MCC1558
 MCF1558
 Flip-Chip — MCCF1558
 MCCF1458

Available Variations:

Prime Device — MC1747
 $T_A = -55$ to $+125^{\circ}\text{C}$
 Relaxed Spec. — MC1747C
 $T_A = 0$ to $+75^{\circ}\text{C}$
 Military Qualification
 or Process Devices Available — MC1747

ELECTRICAL SPECIFICATIONS — (Prime Devices)

| Device Type | I_{IB} μA Max | V_{IO} mV Max | I_{IO} nA Max | A_{VOL} V/V Min | f_c MHz Typ | BW_p kHz Typ | SR V/ μs Typ | Case |
|-------------|----------------------------------|-----------------------|-----------------------|-------------------------|---------------------|----------------------|-------------------------------|--------------------|
| MC1537 | 0.5 | 5.0 | 200 | 25 k | 1.0 | 3.0 | 0.25 | 632 |
| MC1558 | 0.5 | 5.0 | 200 | 50 k | 1.1 | 14 | 0.8 | 601, 632, 693 |
| MC1747 | 0.5 | 5.0 | 200 | 50 k | 1.0 | 10 | 0.5 | 601, 603, 607, 646 |

QUAD OPERATIONAL AMPLIFIERS

MC3503

High performance, compensated quad operational amplifier with specifications similar to MC1741, but with lower power requirements. Operates with single or split power supplies.

Available Variations:

Prime Device — MC3503
 $T_A = -55$ to $+125^{\circ}\text{C}$
 Relaxed Spec. — MC3403
 $T_A = 0$ to $+70^{\circ}\text{C}$

MC3401

Low cost amplifier with four independent circuits ideal for active filters, multi-channel amplifiers and similar applications.
 $T_A = 0$ to $+75^{\circ}\text{C}$

MC3301

Similar to MC3401, except with much greater temperature range suitable for wide under hood temperature variations in automotive applications.

$T_A = -40$ to $+85^{\circ}\text{C}$

ELECTRICAL SPECIFICATIONS

| Device Type | I_{IB} μA Max | V_{IO} mV Max | I_{IO} nA Max | A_{VOL} V/V Min | f_c MHz Typ | BW_p kHz Typ | SR V/ μs Typ | Case |
|-------------|----------------------------------|-----------------------|-----------------------|-------------------------|---------------------|----------------------|-------------------------------|----------|
| MC3301 | 0.3 | — | — | 1 k | 4.0 | 20 | 0.6 | 646 |
| MC3401 | 0.3 | — | — | 1 k | 5.0 | 20 | 0.6 | 646 |
| MC3403 | 0.5 | 8.0 | 200 | 20 k | 1.0 | 9.0 | 0.6 | 632, 646 |
| MC3503 | 0.5 | 5.0 | 200 | 50 k | 1.0 | 9.0 | 0.6 | 632 |

OTHER OPERATIONAL AMPLIFIERS

The following operational amplifier types are also manufactured by Motorola. These device types are recommended for exact replacement only.

| | | |
|--------------------------------------|--------------------------------------|-------------------|
| MC1430 MC1431 MC1433 MC1435 | MC1530 MC1531 MC1533 MC1535 | MC1712 MC1712C |
|--------------------------------------|--------------------------------------|-------------------|

A variety of high-frequency circuits with features ranging from low-cost simplicity to multi-function versatility marks Motorola's line of integrated RF/IF amplifiers. Devices described here are intended for industrial and communica-

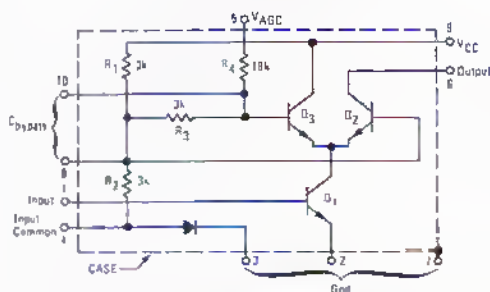
tions applications. For devices especially dedicated to consumer products, i.e., TV and entertainment radio, see Consumer Applications Selector Guide.

AGC AMPLIFIERS

MC1550 — Low Cost Building Block

Single-stage cascade connected amplifier with delayed AGC characteristics, for operation at frequencies to 100 MHz. Has typical power gain of 25 dB @ 60 MHz. See Application Notes AN-215A, AN-247A and AN-299 for design details.

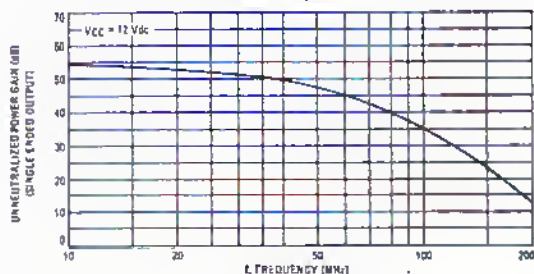
CIRCUIT SCHEMATIC



MC1590 — Wide-Band General Purpose

Has differential inputs and outputs with unneutralized power gain as high as 35 dB typical at 100 MHz in tuned amplifier service. Effective AGC voltage range from 5 to 7 volts for a 30 dB gain reduction. See Application Note AN-513 for design details.

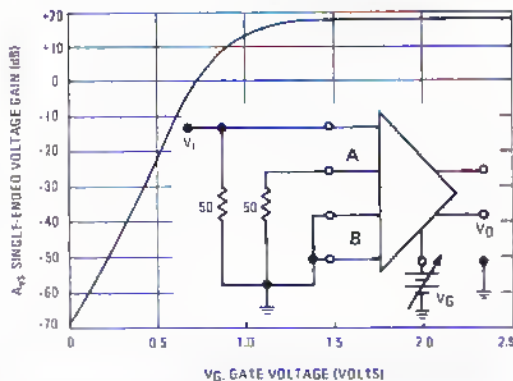
UNNEUTRALIZED POWER GAIN versus FREQUENCY (Tuned Amplifier)



MC1545/MC1445 — Gated 2-Channel Input

Differential input and output amplifier with gated 2-channel input for a wide variety of switching purposes. Typical 75 MHz bandwidth makes it suitable for high-frequency applications such as video switching, FSK circuits, multiplexers, etc.. Gating circuit is useful for AGC control. See Application Notes AN-475 and AN-491 for design details.

GATE CHARACTERISTICS



AGC AMPLIFIERS ELECTRICAL SPECIFICATIONS

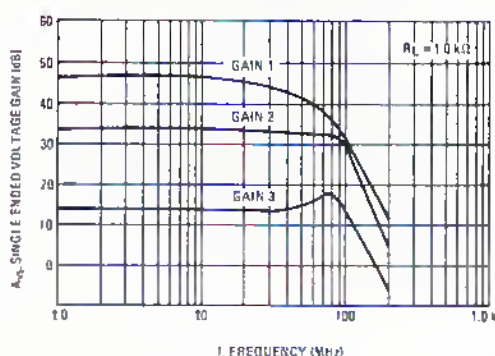
| Operating Temperature Range | | Av dB | Bandwidth MHz | VCC/VEE Vdc | Case | Special Features |
|-----------------------------|------------|---------------------|------------------|----------------|--------------|---|
| -55 to +125°C | 0 to +75°C | | | | | |
| MC1550 | — | 22 Min | 22 | +6/- | 602B,606 | Low-Cost |
| MC1590 | — | 44 Typ @ 4 Typ @ | 10 100 | +12/- | 601 | Characterized as Video Amplifier and as High Frequency Tuned Amplifier |
| MC1545 | MC1445 | 19 Typ @ | 75 | +5/-5 | 602A,607,632 | Gate Controlled 2-Channel Input |

NON-AGC AMPLIFIERS

MC1733/MC1733C – Utility Amplifier

Differential input and output amplifier provides three fixed gain options with bandwidth to 120 MHz. External resistor permits any gain setting from 10 to 400 V/V. Extremely fast rise time (2.5 ns typ) and propagation delay time (3.6 ns typ) makes this unit particularly useful as pulse amplifier in tape, drum, or disc memory read applications.

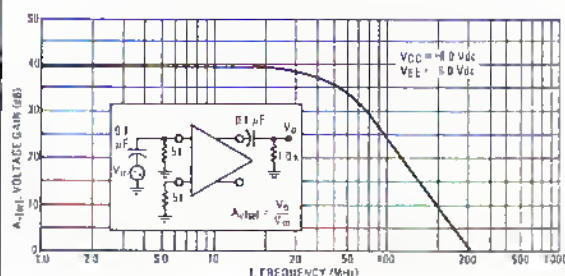
GAIN versus FREQUENCY



MC1510/MC1410 – General-Purpose Amplifier

Differential amplifier with flat response to 40 MHz. Provides excellent performance and simple design for most video and communications purposes.

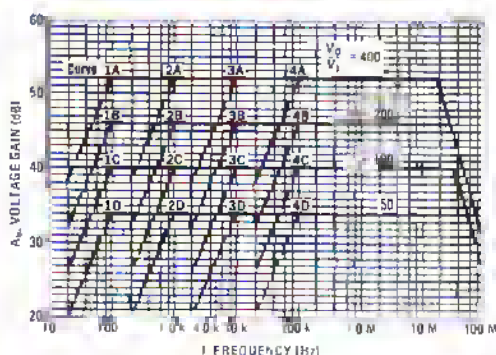
VOLTAGE GAIN versus FREQUENCY



MC1552/MC1553 – Low Distortion Amplifier

Extremely high performance amplifier with internal series feedback for stable voltage gain and low distortion. Temperature compensation stabilizes operating point. Has selectable gain option and well characterized data that permits accurate response shaping (see graph). Useful for critical applications such as wideband linear amplifiers or fast-rise pulse amplifiers.

FREQUENCY RESPONSE



NON AGC AMPLIFIERS ELECTRICAL SPECIFICATIONS

| Operating Temperature Range -55 to +125°C 0 to +75°C | | A _v dB | Bandwidth MHz | V _{CC} /V _{EE} Vdc | Case | Special Features |
|---|---------|----------------------------|------------------|---|---------|--|
| MC1733 | MC1733C | 52 @ 40 40 90 20 120 | | +6/-6 | 603,632 | 3-Fixed Gain Options. Fast Rise Time and Propagation |
| MC1510 | MC1410 | 40 | 40 | +6/-6 | 601 | |
| MC1553 | — | 46 @ 35 52 15 | | +6/-6 | 602B | High and Low Gain Versions a precision amplifier with distortion as low as 0.2% at 200 kHz. |
| MC1552 | — | 34 @ 40 40 @ 35 | | +6/-6 | 602B | |

FIXED OUTPUT VOLTAGE REGULATORS

Low cost, dedicated, monolithic circuits for positive and/or negative regulation requirements from 100 mA to 1.5 A. Most are available in plastic and metal packages. Consult the data sheets for more detailed specifications.

POSITIVE 1.5 A — MC7800 Series

Family Characteristics:

- 0 to +125°C Junction Temperature
- I_O — 1.5 A (Max)
- V_O — ±5% of nominal voltage for all line and load condition limits

| Nominal V_O | V_I (dc) | | Device Type |
|------------------|------------|------|-------------|
| | Min | Max | |
| 5 V | 7 V | 35 V | MC7805C |
| 6 V | 8 V | 35 V | MC7806C |
| 8 V | 10.5 V | 35 V | MC7808C |
| 12 V | 14.5 V | 35 V | MC7812C |
| 15 V | 17.5 V | 35 V | MC7815C |
| 18 V | 21 V | 35 V | MC7818C |
| 24 V | 27 V | 40 V | MC7824C |

*Also available as the:

- MLM109 (-55 to +150°C)
- MLM209 (-25 to +125°C)
- MLM309 (0 to +125°C)



CASE 199-04
(P Suffix)



CASE 11
(K Suffix)

POSITIVE, 500 mA — MC78M00 Series

Family Characteristics:

- 0 to +125°C Junction Temperature
- I_O — 500 mA (Max)
- V_O — ±5% of nominal voltage for all line and load condition limits.

| Nominal V_O | V_I (dc) | | Device Type |
|------------------|------------|------|-------------|
| | Min | Max | |
| 5 V | 7 V | 35 V | MC78M05C |
| 6 V | 8 V | 35 V | MC78M06C |
| 8 V | 10.5 V | 35 V | MC78M08C |
| 12 V | 14.5 V | 35 V | MC78M12C |
| 15 V | 17.5 V | 35 V | MC78M15C |
| 18 V | 21 V | 35 V | MC78M18C |
| 24 V | 27 V | 40 V | MC78M24C |



CASE 199-04
(P Suffix)



CASE 79-02
TO 39
(G Suffix)

NEGATIVE, 1.5 A — MC7900 Series

Family Characteristics:

- 0 to +125°C Junction Temperature
- I_O — 1.5 A (Max)
- V_O — ±5% of nominal voltage for all line and load condition limits.

| Nominal V_O | V_I (dc) | | Device Type |
|------------------|------------|------|-------------|
| | Min | Max | |
| 2 V | 7.2 V | 35 V | MC7902C |
| 5 V | 7 V | 35 V | MC7905C |
| 5.2 V | 7 V | 35 V | MC7905.2C |
| 6 V | 8 V | 35 V | MC7906C |
| 8 V | 10.5 V | 35 V | MC7908C |
| 12 V | 14.5 V | 35 V | MC7912C |
| 15 V | 17.5 V | 35 V | MC7915C |
| 18 V | 21 V | 35 V | MC7918C |
| 24 V | 27 V | 40 V | MC7924C |



CASE 199-04
(P Suffix)



CASE 11
(K Suffix)

POSITIVE, 750 mA — MC7700 Series

Family Characteristics:

- 0 to +125°C Junction Temperature
- I_O — 750 mA (Max)
- V_O — ±5% of nominal voltage for all line and load condition limits.

| Nominal V_O | V_I (dc) | | Device Type |
|------------------|------------|------|-------------|
| | Min | Max | |
| 5 V | 7 V | 35 V | MC7705C |
| 6 V | 8 V | 35 V | MC7706C |
| 8 V | 10.5 V | 35 V | MC7708C |
| 12 V | 14.5 V | 35 V | MC7712C |
| 15 V | 17.5 V | 35 V | MC7715C |
| 18 V | 21 V | 35 V | MC7718C |
| 20 V | 23 V | 40 V | MC7720C |
| 24 V | 27 V | 40 V | MC7724C |



CASE 199-04
(P Suffix)



CASE 79-02
TO 39
(G Suffix)

POSITIVE, 100 mA — MC78L00 Series

Family Characteristics:

- 0 to +125°C Junction Temperature
- I_O — 100 mA (Max)
- V_O — ±10% of nominal voltage for all line and load condition limits.

| Nominal V_O | V_I (dc) | | Device Type |
|------------------|------------|------|-------------|
| | Min | Max | |
| 5 V | 7 V | 30 V | MC78L05C |
| 8.1 V | 10.5 V | 30 V | MC78L08C |
| 12 V | 10.5 V | 35 V | MC78L12C |
| 15 V | 17.5 V | 35 V | MC78L15C |
| 18 V | 21 V | 35 V | MC78L18C |
| 24 V | 27 V | 40 V | MC78L24C |



CASE 29-02
TO 92
(P Suffix)



CASE 79-02
TO 39
(G Suffix)

NEGATIVE, 100 mA — MC79L00 Series

Family Characteristics:

- 0 to +125°C Junction Temperature
- I_O — 100 mA (Max)
- V_O — ±10% of nominal voltage for all line and load condition limits.

| Nominal V_O | V_I (dc) | | Device Type |
|------------------|------------|------|-------------|
| | Min | Max | |
| 3 V | 5 V | 30 V | MC79L03C |
| 5 V | 7 V | 30 V | MC79L05C |
| 12 V | 14.5 V | 35 V | MC79L12C |
| 15 V | 17.5 V | 35 V | MC79L15C |
| 18 V | 21 V | 35 V | MC79L18C |
| 24 V | 27 V | 40 V | MC79L24C |



CASE 29-02
TO 92
(P Suffix)



CASE 79-02
TO 39
(G Suffix)

DUAL (±15 V Output) 100 mA
REGULATOR

The MC1568 features an output balance of ±1% maximum (±2% for MC1468), current limit control and provisions for remote sensing. The ceramic package (L Suffix) has a balance control pin for critical balance requirements. The preset V_O of ±15 V can be varied from ±8 to ±20 V at the sacrifice of performance over temperature.

| | MC1568 | MC1468 |
|--------------------------|--------------|------------|
| Tamp. Range | -55 to +125 | 0 to 75 |
| I_O (Max) | 100 mA | 100 mA |
| V_O | ±15 V, ±2.5% | ±15 V, ±6% |
| V_I (Min/Max) | ±17.2/±30 | ±17.5/±30 |
| Reg (lns) | 0.006 | 0.01 |
| % V_O/V_I (Max) | | |
| Reg (load) (% V_O Max) | 0.07 | 0.07 |



CASE 603
(G Suffix)



CASE 614
(R Suffix)



CASE 632
(L Suffix)

VARIABLE OUTPUT VOLTAGE REGULATORS

When an adjustable or tailored voltage is required, the following regulators should be used. Voltage is set by varying the value of an external resistor or resistors. More complete data on individual devices can be found on the data sheets.



CASE 614 500 mA
(R Suffix)



CASE 602A 200 mA
(G Suffix)

POSITIVE, 500 mA — 2.5 to 37 V

The MC1569 is a high performance regulator designed for either stand-alone operation or with a current boost transistor. It has an electrical complement, the MC1563 for dual supply applications requiring positive and negative outputs. Ripple rejection is typically 0.002%/V. An electronic shutdown control and remote sensing are also provided.

| Operating Temperature (Junction) | -55 to +125°C |
|----------------------------------|---------------|
| I_O Max | 500 mA |
| V_O Range | 2.5 to 37 V |
| V_I (Min/Max) | 8.5 to 40 V |
| Regline Max | 0.015%/V $_O$ |
| Regload Max | 0.05% |

Variations:

The MC1469 is a relaxed specification lower cost version of the MC1569 and operates over a 0 to +70°C Junction Temperature Range.

MC1569/MC1469 also available as non-encapsulated chip, use MCC prefix.

MC1561 is the same as the MC1569 but has a much higher transient response. It is also available as the MC1560 which has a reduced V_O range and slightly relaxed specifications. The MC1461 and MC1460 are also available for 0 to +70°C operation.

POSITIVE, 20 mA — 4.5 to 40 V

The MLM105 is also available for low current applications. Line regulation is 0.01%/V and load regulation (no load to full load) 1 mV. Operating temperature is -55 to +125°C ambient.

The MLM205 relaxed specification:

-25 to +85°C

The MLM305 relaxed specification:

0 to +70°C

NEGATIVE, 500 mA — 3.6 to 37 V

The MC1563 is an electrical complement to the MC1569 for construction of positive and negative output regulator systems. In the power package (R Suffix), the case is ground for both types allowing direct mounting on a common heat sink.

Variations:

The MC1463 is a relaxed specification lower cost version of the MC1563 and operates over a 0 to +70°C Junction Temperature Range.

MC1563/MC1463 also available as non-encapsulated chip, use MCC prefix.

| Operating Temperature (Junction) | -55 to +125°C |
|----------------------------------|-------------------|
| I_O Max | 500 mA |
| V_O Range | 3.6 to 37 V |
| V_I (Min/Max) | 8.5 to 40 V |
| Regline | 0.015%/V $_O$ Max |
| Regload | 0.05% Max |

NEGATIVE, 20 mA — 0.015 to 40 V

The MLM104 is also available for low current applications. Line regulation is 0.01%/V and load regulation (no load to full load) 1 mV. Operating temperature is -55 to +125°C (ambient).

The MLM204 relaxed specification:

-25 to +85°C

The MLM304 relaxed specification:

0 to +70°C

LABORATORY SUPPLY, VOLTAGE AND CURRENT REGULATOR

The MC1566 is a floating regulator designed for use with an external series pass NPN transistor. The voltage and current capabilities are limited only by the characteristics of the series element. Some of the more important features include:

- Automatic cross-over between voltage and current regulation
- Adjustable to zero volts or current
- Short circuit protection
- Remote Sensing

| Operating Temperature (Ambient) | -55 to +125°C |
|---------------------------------|---------------|
| Regline & Regload | 0.01% + 1 mV |
| Regcurrent | 0.1% + 1 mA |

Variations:

The MC1466 is a lower cost relaxed specification version of the MC1566 for operation from 0 to +75°C (ambient).



CASE 603
(G Suffix)



CASE 602A
(G Suffix)



CASE 614 500 mA
(R Suffix)



CASE 603
(G Suffix)



CASE 603
(G Suffix)



CASE 646
(IP Suffix)



CASE 632
(IL Suffix)

POSITIVE, 150 mA — 2 to 37 V

The MC1723 is a very popular, lower current regulator for either stand-alone use or in conjunction with a current boost transistor. Three package variations are available: Metal (G Suffix), dual-in-line ceramic (L Suffix), or Plastic (P Suffix).

| Operating Temperature (Ambient) | -55 to +125°C |
|---------------------------------|---------------|
| I_O Max | 150 mA |
| V_O Range | 2 to 37 V |
| V_I (Min/Max) | 9.5 to 40 V |
| Regline Max | 0.2% V_O |
| Regload Max | 0.15% V_O |

Variations:

The MC1723C is a lower cost relaxed specification of the MC1723 for operation over the temperature range of 0 to +75°C (ambient).

The MC1723/MC1723C also available as nonencapsulated chip, use MCC prefix. MC1723 also available as nonencapsulated beam-lead device; use MCBC prefix, use MCB prefix for device in ceramic flat package.

MC1723 — High reliability processed versions offered.



CASE 632
(IL Suffix)

SPECIAL-PURPOSE CIRCUITS

The linear-integrated-circuits listed in this section were developed by Motorola for the system design engineer to fill special-purpose requirements as indicated

by the subheadings. Temperature ranges and package availability are also tailored to provide versatility.

MULTIPLIERS

| Function | Linearity Error typ | Input Voltage Range V _{dc} min | Case | Type | |
|--|----------------------------------|---|------|---------------|------------|
| | | | | -55 to +125°C | 0 to +70°C |
| A four-quadrant multiplier designed to operate with ± 15 -volt supplies, has internal level-shift circuitry and voltage regulator. | $\pm 0.3\%$ | ± 10 | 620 | MC1594 | — |
| | $\pm 0.5\%$ | ± 10 | 620 | — | MC1494 |
| Applications include multiply, divide, square root, mean square, phase detector, frequency doubler, balanced modulator/demodulator, electronic gain control. | X Input = 0.5% Y Input = 1.0% | ± 10 | 632 | MC1595* | — |
| | X Input = 1.0% Y Input = 2.0% | ± 10 | 632 | — | MC1495* |

*Also available as a nonencapsulated chip, use MCC prefix.

BALANCED MODULATOR/DEMODULATOR

| Function | Carrier Suppression dB @ f typ MHz | | Common-Mode Rejection dB typ | Case | Type | |
|--|------------------------------------|-----|------------------------------|----------------|---------------|------------|
| | | | | | -55 to +125°C | 0 to +75°C |
| Balanced modulator/demodulator designed for use where the output voltage is a product of an input voltage (signal) and a switching function (carrier). | 65 | 0.5 | 85 | 602A, 632 | MC1596 | MC1496 |
| | 50 | 10 | | 602A, 632, 646 | | |

LOW-FREQUENCY CIRCUITS

| Function | Output Power W typ | Voltage Gain — typ V/V typ | Total Harmonic Distortion % typ | Case | Type | |
|---|--------------------|----------------------------|---------------------------------|------|---------------|------------|
| | | | | | -55 to +125°C | 0 to +70°C |
| A power amplifier device capable of single or split supply operation. | 1.0 | 10, 18, 36 | 0.4 | 602B | MC1554 | MC1454 |

TIMING CIRCUITS

| Function | Supply Voltage V _{CC} V _{dc} — max | Initial Timing Error V _{CC} = 5 & 15 V, C = 0.1 μ F %-typ | V _{DL} V _{CC} = 15 V I _{sink} = 50 mA V _{dc} — max | V _{OH} V _{CC} = 15 V I _{source} = 100 mA V _{dc} — min | Case | Type | |
|------------------------------|--|--|--|---|---------------|---------------|------------|
| | | | | | | -55 to +125°C | 0 to +75°C |
| Wide range adjustable timers | 16 | 1.0 | 0.75 | 12.75 | 601, 626, 693 | — | MC1455 |
| | 18 | 0.5 | 0.5 | 13 | 601, 693 | MC1555 | — |
| Dual Adjustable Timers | 16 | 2.25 | 0.75 | 12.75 | 632, 646 | — | MC3456 |
| | 18 | 1.5 | 0.5 | 13 | 632 | MC3556 | — |

...reflecting Motorola's continuing commitment to semiconductor products necessary for consumer system designs. The tabulation contains data for a large number of components designed principally for entertainment

product applications. It is arranged to simplify first-order of linear integrated circuit device lineups to satisfy primary functions for Television, Audio, Radio, Automotive and Organ applications.

TELEVISION CIRCUITS

SOUND

| Function | Features | Case | Type |
|--|--|---------|--------|
| Sound IF, Detector, Limiter, Audio Preamplifier | 80 μ V, 3 dB Limiting Sensitivity, 3.5 V RMS Output, Sufficient for Single Transistor Output Stage | 646,647 | MC1351 |
| Sound IF Detector | Interchangeable with ULN2111A | 646,647 | MC1357 |
| Sound IF Detector, DC Volume Control, Preamplifier | Excellent AMR, Interchangeable with CA3065 | 646,647 | MC1358 |

VIDEO

| | | | |
|---|--|---------|--------|
| 1st and 2nd Video IF Amplifier | IF Gain @ 45 MHz - 60 dB typ, AGC Range - 70 dB min | 626 | MC1349 |
| | IF Gain @ 45 MHz - 46 dB typ, AGC Range - 60 dB min | 626 | MC1350 |
| 1st and 2nd Video IF, AGC Keyer and Amplifier | IF Gain @ 45 MHz - 53 dB typ, AGC Range - 65 dB min, "Forward AGC" Provided for Tuner | 646,647 | MC1352 |
| | Same as MC1352, with Opposite AGC for Tuner | 646,647 | MC1353 |
| 3rd IF and Video Detector | Low-Level Detection, Low Harmonic Generation, Reduced Circuit Cost and Complexity, Reduced Shielding | 626 | MC1330 |
| 3rd IF, Video Detector, Sound IF Detector, and Sync Separator | Low-Level Detection, Separate Sound Detector, Differential Input | 646 | MC1331 |
| AGC Keyer, AGC Amplifier, Noise Gate, Sync Separator | High-Quality Noise Gate, One IF AGC Output and Two Tuner AGC Outputs, Adjustable AGC Delay | 646 | MC1344 |
| Automatic Fine Tuning | High Gain AFT System, Interchangeable with CA3064 | 646 | MC1364 |
| | | 686 | |

CHROMA

| | | | |
|---|--|---------------|--------|
| Chroma IF Amplifier and Subcarrier System | Includes Complete Chroma IF, AGC, dc Gain and Tuning Controls, Injection Locked Oscillator, Low Peripheral Parts Count | 646 | MC1398 |
| Chroma Subcarrier System | Interchangeable with CA3070, APC Chroma Reference System | 648 | MC1370 |
| Chroma IF Amplifier | Interchangeable with CA3071, Automatic and Manual Gain Control | 646 | MC1371 |
| Dual Chroma Demodulators | Industry Standard Demodulator, Low Differential Output dc Drift | 603, 646, 647 | MC1328 |
| | Same as MC1328 with short-circuit protected output, and improved dc tracking and temperature coefficients on outputs | 646 | MC1329 |
| | Similar to MC1328 but with Luminance and Blanking Inputs, Internal Matrix Provides RGB Outputs | 646,647 | MC1326 |
| | Same as MC1328 with short-circuit protected outputs, and improved dc tracking and temperature coefficients on output | 646 | MC1324 |
| | Dual Doubly Balanced Demodulator with RGB Output Matrix and PAL Switch | 646,647 | MC1327 |
| Triple Chroma Demodulator | Triple Doubly Balanced Demodulator with Adjustable Output Matrix, Contains Three Independent Demodulators | 648 | MC1323 |

DEFLECTION

| | | | |
|--------------------------|---|-----|--------|
| Horizontal Processor | Includes Phase-Detector, Oscillator and Predriver, Linear Balanced Phase Detector, Adjustable dc Loop Gain | 626 | MC1391 |
| Horizontal Processor | Same as MC1391 except designed to accept negative sawtooth sync pulse | 626 | MC1394 |
| Color Processing Circuit | Includes chroma IF amplifier with ACC, color killer, linear dc chroma control, phase locked loop subcarrier regenerator with dc hue control | 648 | XC1399 |

AUDIO CIRCUITS

PREAMPLIFIERS

| Function | V _{CC} V _{dc} — max | A _{vol} dB min | THD % typ | Z _o Ohms typ | Case | Type |
|-------------------|--|----------------------------|--------------|----------------------------|------|--------|
| Dual Preamplifier | ±15 | 80 | 0.1 | 100 | 632 | MC1303 |

DRIVERS

| Function | V _{CC} V _{dc} — max | Drive Current mA | A _{vol} dB | Case | Type |
|-----------------------|--|---------------------|------------------------|------|--------|
| Class B Audio Drivers | 60 | — | 90 typ | 646 | XC1387 |
| | 25 | 50 max | — | 646 | MC1385 |

POWER AMPLIFIERS

| Function | P _D Watts | V _{CC} V _{dc} max | I _{in} @ rated P _D mV (RMS) typ | P _D mA — max | R _L Ohms | Case | Type |
|------------------------|-------------------------|--|---|----------------------------|------------------------|------|---------|
| Audio Power Amplifiers | 0.5 | 12 | 3.0 | 4.0 | 8.0 | 626 | MC1306 |
| | 0.25 | 12 | 3.0 | 3.5 | 16 | 626 | MC3360P |

RADIO CIRCUITS

IF AMPLIFIERS

| Function | Gain @ 10.7 MHz dB — typ | 3 dB Limiting @ 10.7 MHz mV (RMS) typ (μV/RMS)* | AMR dB — typ min* | Recovered Audio Output Δf = 75 kHz mV (RMS) | Power Supply Volts — max | Case | Type |
|---|--------------------------------|--|-------------------------|--|--------------------------------|----------|---------|
| IF Amplifier | 58 | 0.175 | 60 | 690 | 18 | 626 | MC1350 |
| Limiting FM-IF Amplifier | — | 0.600 | 45 | 480 | 18 | 646, 647 | MC1355 |
| Limiting IF Ampl/Quadrature Detector | 53 | 0.4 | — | — | 16 | 646, 647 | MC1357 |
| IF Amplifier | 42 | 60 | 50 | 500 | 18 | 626 | MC3310P |
| IF Amplifier, Limiter, Detector, Audio Preamplifier | 21 | — | — | — | 16 | 646 | MC1375 |
| IF Amplifier Quad Detector, AF pre- Amplifier, AFC, AGC, Muting and Tuning Meter Circuits | — | 18* | 60* | 300 | 16 | 648 | XC1389 |
| Limiting IF Ampl/Quadrature Detector with Built-In Regulator | Similar to MC1357 | | | | | 646, 647 | MC1356 |

DECODERS

| Function | Channel Separation dB — typ | THD % — typ | Stereo — Indicator Lamp Driver mA — max | Features | Case | Type |
|--|-----------------------------------|----------------|---|---|------|---------|
| FM Multiplex Stereo Decoders | 45 | 0.5 | 40 | Audio Muting | 646 | MC1304 |
| | 45 | 0.5 | 40 | Audio Muting | 646 | MC1306 |
| | 40 | 0.5 | 40 | — | 646 | MC1307 |
| | 40 | 0.3 | 75 | Coilless Operation | 646 | MC1310 |
| | 40 | 0.5 | 100 | Coilless Operation, Emitter Follower Outputs, and Unity Gain | 648 | MC1311* |
| Four-Channel SQ* Decoders | 45 | 0.1 | — | V _{CC} = 20 V _{dc} nom | 646 | MC1312 |
| Four Channel SQ* Gain and Balance Control | — | — | — | Master Volume Control and LF/RF, LB/RB, E/B Balance Control | 646 | MC1314 |
| Four Channel SQ* Logic Circuit | — | — | — | Interface with MC1314 and MC1312 to increase F/B Separation and Supply Gain and Balance Control to MC1314 | 646 | MC1315 |

* Trademark of Columbia Broadcasting System, Inc.

SPECIAL FUNCTIONS

| Function | Toggle Frequency kHz Typ | Power Supply Volts Max | Case | Type |
|---------------------------------------|--------------------------------|------------------------------|------|--------|
| Emitter-Coupled Astable Multivibrator | 100 | 10 | 626 | MC3380 |

* To be introduced

AUTOMOTIVE CIRCUITS

OPERATIONAL AMPLIFIER

| Function | V _{CC} Range Vdc | A _{vol} V/mV – typ | I _B μA – max | Unity Gain Bandwidth MHz – typ | R _{in} MΩ typ | Case | Type |
|----------------------------|---------------------------------|--------------------------------|----------------------------|--------------------------------------|---------------------------|------|--------|
| Quad Operational Amplifier | 4.0 to 28 | 2.0 | 0.3 | 4.0 | 1.0 | 646 | MC3301 |

COMPARATOR

| Function | V _{CC} Range Vdc | V _{IDR} Vdc | I _B μA – max | Output Leakage Current μA – max | Sink Current | Case | Type |
|---|---------------------------------|-------------------------|--|---------------------------------------|--------------|------------------|---|
| Quad Comparator | 2.0 to 28 | ±V _{CC} | 0.5 | 1.0 | 6.0 | 646 | MC3302 |
| Quad Comparator (Single/Dual Supply) | 2.0 to 36 ↓ | 36 ↓ | 100 250 250 100 250 250 | 0.1 ↓ | 6.0 ↓ | 646/ 632 ↓ | MLM139 MLM239 MLM339 MLM139A MLM239A MLM339A |

ORGAN CIRCUITS

FREQUENCY DIVIDERS


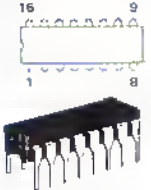

| Function | V _{CC} Range Vdc | f _{Tog} MHz – typ | V _{OH} Vdc – min | Case | Type |
|-----------------|---------------------------------|-------------------------------|------------------------------|------|----------|
| 7-Stage Divider | 6.0 to 16 | 3.0 | 15.5 | 646 | XC1302 ● |

ATTENUATOR

| Function | V _{CC} Range Vdc | THD % – typ | A _V dB – typ | Attenuation Range dB – typ | Case | Type |
|-----------------------|---------------------------------|----------------|----------------------------|----------------------------------|------|---------|
| Electronic Attenuator | 9.0 to 18 | 0.6 | 13 | 90 | 626 | MC3340P |

● To be announced

LINEAR IC PACKAGES

| | | | | |
|---|---|---|--|--|
|  <p>CASE 11 (TO-3) Suffix K after type number</p> |  <p>CASE 29-02 TO-92 Suffix P after type number</p> |  <p>CASE 79-02 (TO-39) Suffix G after type number</p> |  <p>CASE 199-04 Suffix P after type number</p> |  <p>CASE 206A No Suffix</p> |
|  <p>CASE 601 Suffix G after type number</p> |  <p>CASE 602A Suffix G after type number</p> |  <p>CASE 602B Suffix G after type number</p> |  <p>CASE 603 (TO-100) Suffix G after type number</p> |  <p>CASE 606 (TO-91) Suffix F after type number</p> |
|  <p>CASE 607 Suffix F after type number</p> |  <p>CASE 614 Suffix R after type number</p> |  <p>CASE 620 Suffix L after type number</p> |  <p>CASE 623 Suffix L after type number</p> |  <p>CASE 626 Suffix P or PL after type number</p> |
|  <p>CASE 632 (TO-116) Suffix L after type number</p> |  <p>CASE 646 Suffix P after type number</p> |  <p>CASE 647 Suffix PQ after type number</p> |  <p>CASE 648 Suffix P after type number</p> |  <p>CASE 649 Suffix P after type number</p> |
|  <p>CASE 650 Suffix F after type number</p> |  <p>CASE 686 Suffix G after type number</p> |  <p>CASE 693 Suffix U after type number</p> |  <p>CASE 701 Suffix P after type number</p> |  |



SILICON POWER TRANSISTORS

This Selector Guide is to help the designer choose the best silicon power transistor for his new equipment and find suitable replacements for devices used in older designs. It is a comprehensive listing of the industry's most complete line of PNP and NPN silicon power transistors, and the devices are rated at currents between 100 mA and 60 amperes, and at voltages up to 1500 volts.

Motorola has the production capability and flexibility to supply devices especially tailored to specific application needs. Where suitable power transistors cannot be selected from this guide, contact your nearest Motorola sales representative or distributor.

TABLE OF CONTENTS

| | PAGE |
|---|------|
| General-Purpose Silicon Power Transistors | |
| Representing over 200 "best value" selected devices for new designs | 4-3 |
| Power Darlington Transistors | |
| High current gain Darlington devices for use in a variety of applications | 4-8 |
| Power Switchmode Transistors | |
| Designed for high-voltage, high-speed, power switching in inductive circuits where fall time is critical. | 4-7 |
| High Voltage Transistors | |
| Devices intended for industrial, commercial and military equipment | 4-9 |
| High Frequency Transistors | |
| Designed for a wide variety of power amplifier and high-speed saturated switching applications. . . | 4-11 |
| Motorola Replacements for the Popular TIP Series | 4-12 |

The following index reflects the devices characterized in this section. To locate the exact page number, see Catalog Index (Page 7-1).

INDEX

| | | | | |
|---------|--------|--------|--------|----------|
| 2N3054A | 2N5675 | 2N6277 | 2N6499 | MJE41 |
| 2N3055 | 2N5676 | 2N6262 | 2N6542 | MJE41A |
| 2N3439 | 2N5677 | 2N6263 | 2N6643 | MJE41B |
| 2N3440 | 2N6676 | 2N6284 | 2N6644 | MJE41C |
| 2N3583 | 2N5679 | 2N6285 | 2N6545 | MJE42 |
| 2N3584 | 2N5660 | 2N6286 | 2N6546 | MJE42A |
| 2N3585 | 2N5661 | 2N6267 | 2N6647 | MJE42B |
| 2N3716 | 2N5682 | 2N6294 | 2N6569 | MJE42C |
| 2N3716 | 2N5683 | 2N6295 | 2N6576 | MJE47 |
| 2N3736 | 2N5684 | 2N6296 | 2N6577 | MJE48 |
| 2N3739 | 2N5685 | 2N6297 | 2N6576 | MJE49 |
| 2N3740 | 2N5688 | 2N6296 | BU100 | MJE51 |
| 2N3741 | 2N5686 | 2N6299 | 6U126 | MJE52 |
| 2N3791 | 2N5687 | 2N6300 | 6U205 | MJE53 |
| 2N3792 | 2N5686 | 2N6301 | 6U206 | MJE200 |
| 2N3867 | 2N5689 | 2N6303 | MJ206 | MJE210 |
| 2N3666 | 2N6990 | 2N6306 | MJ413 | MJE340 |
| 2N3902 | 2N6991 | 2N6307 | MJ423 | MJE340K |
| 2N4231A | 2N6029 | 2N6308 | MJ425 | MJE350 |
| 2N4232A | 2N6030 | 2N6312 | MJ802 | MJE520 |
| 2N4233A | 2N6031 | 2N6313 | MJ804 | MJE700 |
| 2N4234 | 2N6034 | 2N6314 | MJ900 | MJE800 |
| 2N4240 | 2N6035 | 2N6338 | MJ1000 | MJE1100 |
| 2N4396 | 2N6037 | 2N6339 | MJ2253 | MJE2160 |
| 2N4399 | 2N6036 | 2N6340 | MJ2254 | MJE2955 |
| 2N4918 | 2N6039 | 2N6341 | MJ2965 | MJE2955K |
| 2N4919 | 2N6040 | 2N6377 | MJ3760 | MJE3055 |
| 2N4920 | 2N6041 | 2N6378 | MJ3761 | MJE3055K |
| 2N4921 | 2N6042 | 2N6379 | MJ4502 | MJE3300 |
| 2N4922 | 2N6043 | 2N6363 | MJ6415 | MJE3301 |
| 2N4923 | 2N6044 | 2N6364 | MJ6416 | MJE3302 |
| 2N5190 | 2N6045 | 2N6365 | MJ7160 | MJE3310 |
| 2N5191 | 2N6049 | 2N6405 | MJ7161 | MJE3311 |
| 2N6182 | 2N6050 | 2N6407 | MJ7260 | MJE3312 |
| 2N5193 | 2N6051 | 2N6408 | MJ7261 | MJE3439 |
| 2N5194 | 2N6052 | 2N6409 | MJE29 | MJE3440 |
| 2N5195 | 2N6053 | 2N6410 | MJE29A | MJE5190 |
| 2N5301 | 2N6064 | 2N6411 | MJE296 | MJE5191 |
| 2N5302 | 2N6055 | 2N6412 | MJE29C | MJE5192 |
| 2N5303 | 2N6056 | 2N6413 | MJE30 | MJE5293 |
| 2N6304 | 2N6057 | 2N6414 | MJE30A | MJE5194 |
| 2N5629 | 2N6056 | 2N6415 | MJE30B | MJE6195 |
| 2N6630 | 2N6059 | 2N6416 | MJE30C | MJE6655 |
| 2N5631 | 2N6226 | 2N6417 | MJE31 | MJE6656 |
| 2N5632 | 2N6227 | 2N6418 | MJE31A | MJE6657 |
| 2N5633 | 2N6228 | 2N6419 | MJE31B | MJE6974 |
| 2N5634 | 2N6229 | 2N6420 | MJE31C | MJE6975 |
| 2N6655 | 2N6230 | 2N6421 | MJE32 | MJE6976 |
| 2N5666 | 2N6231 | 2N6422 | MJE32A | MJE6977 |
| 2N5657 | 2N6233 | 2N6423 | MJE32B | MJE6978 |
| 2N5683 | 2N6234 | 2N6424 | MJE32C | MJE6979 |
| 2N5664 | 2N6235 | 2N6426 | MJE33 | MJE6960 |
| 2N5666 | 2N6249 | 2N6436 | MJE33A | MJE5961 |
| 2N5686 | 2N6250 | 2N6437 | MJE33B | MJE5962 |
| 2N5745 | 2N6261 | 2N6438 | MJE33C | MJE5963 |
| 2N6756 | 2N6274 | 2N6496 | MJE34 | MJE5964 |
| 2N5759 | 2N6275 | 2N6497 | MJE34A | MJE5965 |
| 2N5760 | 2N6276 | 2N6498 | MJE34B | MPC900 |
| | | | MJE34C | MPC1000 |

General-Purpose Silicon Power Transistors

From over 1400 power device types available from Motorola, the following represent over 200 "best value", selected devices for new designs. These devices are rated primarily on performance, price and availability. It is recommended that these standard device types be given first consideration for new design.

The device types are listed in increasing order of I_C continuous and V_{CEO} ratings. Other basic data is provided to enable the designer to have a wider field of choice — be it polarity, parameter, case style, process type, or complementary device types. Contact your nearest Motorola sales office for assistance in additional device selection and complete technical data.

| Device and Polarity | | V_{CEO} Volts Max | h_{FE} Min/Max | @ I_C Amp | $V_{CE(sat)}$ Volts Max | @ I_C Amp | f_T MHz Min | P_D Watts Max | Case |
|---------------------|--------|---------------------------|---------------------|-------------------|-------------------------------|-------------------|---------------------|-----------------------|------|
| NPN | | | | | | | | | |
| 0.3 Amp | | | | | | | | | |
| MJE3440 | | 250 | 40/160 | 0.02 | 0.5 | 0.05 | 15 | 15 | 77 |
| MJE3438 | | 350 | 40/160 | 0.02 | 0.5 | 0.05 | 15 | 15 | 77 |
| 0.5 Amp | | | | | | | | | |
| 2N5855 | | 250 | 30/250 | 0.1 | 1.0 | 0.1 | 10 | 20 | 77 |
| MJE5855 | | 250 | 30/250 | 0.1 | 1.0 | 0.1 | 10 | 30 | 199 |
| 2N5856 | | 300 | 30/250 | 0.1 | 1.0 | 0.1 | 10 | 20 | 77 |
| MJE5856 | | 300 | 30/250 | 0.1 | 1.0 | 0.1 | 10 | 30 | 199 |
| MJE340K | | 300 | 30/240 | 0.05 | | | | 30 | 199 |
| | | 300 | 30/240 | 0.05 | | | | 20 | 77 |
| MJE340 | | 300 | 30/240 | 0.05 | | | | 20.8 | 77 |
| MJE5657 | | 350 | 30/250 | 0.1 | 1.0 | 0.1 | 10 | 30 | 199 |
| 2N5657 | | 350 | 30/250 | 0.1 | 1.0 | 0.1 | 10 | 20 | 77 |
| 1.0 Amp | | | | | | | | | |
| MJE29 | MJE30 | 40 | 40/- | 0.2 | 0.7 | 1.0 | 3.0 | 30 | 77 |
| MJE29A | MJE30A | 60 | 40/- | 0.2 | 0.7 | 1.0 | 3.0 | 30 | 77 |
| MJE29B | MJE30B | 60 | 40/- | 0.2 | 0.7 | 1.0 | 3.0 | 30 | 77 |
| MJE29C | MJE30C | 100 | 40/- | 0.2 | 0.7 | 1.0 | 3.0 | 30 | 77 |
| | MJ5415 | 200 | 30/150 | 0.05 | 2.5 | 0.05 | 15 | 10 | 79 |
| 2N3738 | 2N6424 | 225 | 40/200 | 0.1 | 2.5 | 0.25 | 10 | 20 | 80 |
| 2N3440 | | 250 | 40/160 | 0.02 | 0.5 | 0.05 | 15 | 5.0 | 79 |
| | MJ5416 | 300 | 30/120 | 0.05 | 2.5 | 0.05 | 15 | 10 | 79 |
| 2N3739 | 2N6425 | 300 | 40/200 | 0.1 | 2.5 | 0.25 | 10 | 20 | 80 |
| 2N3439 | | 350 | 40/160 | 0.02 | 0.5 | 0.05 | 15 | 5.0 | 31 |
| 1.5 Amp | | | | | | | | | |
| MJE47 | | 250 | 30/250 | 0.3 | 1.0 | 1.0 | 5.0 | 50 | 199 |
| MJE2160 | | 300 | 30/240 | 0.5 | 3.5 | 0.5 | | 50 | 199 |
| MJE48 | | 300 | 30/250 | 0.3 | 1.0 | 1.0 | 5.0 | 50 | 199 |
| MJE49 | | 350 | 30/250 | 0.3 | 1.0 | 1.0 | 5.0 | 50 | 199 |
| 2.0 Amp | | | | | | | | | |
| 2N6408 | 2N6406 | 60 | 50/250 | 0.1 | 2.0 | 2.0 | 50 | 12.5 | 77 |
| 2N6409 | 2N6407 | 80 | 50/250 | 0.1 | 2.0 | 2.0 | 50 | 12.5 | 77 |
| 2N3583 | 2N6420 | 175 | 40/200 | 0.5 | 5.0 | 1.0 | 10 | 35 | 80 |
| 2N3584 | 2N6421 | 250 | 8/80 | 1.0 | 0.75 | 1.0 | 10 | 35 | 80 |
| 2N3585 | 2N6422 | 300 | 8/80 | 1.0 | 0.75 | 1.0 | 10 | 35 | 80 |
| 2N4240 | 2N6423 | 300 | 10/100 | 0.75 | 1.0 | 0.75 | 15 | 35 | 80 |

SILICON POWER TRANSISTORS (Continued)

PREFERRED SILICON POWER TRANSISTORS (continued)

| Device and Polarity | | V_{CE0} Volts Max | h_{FE} Min/Max | I_C Amp | V_{CE1500} Volts Max | I_C Amp | f_T MHz Min | P_D Watts Max | Case |
|---------------------|---------|---------------------------|---------------------|--------------|------------------------------|--------------|---------------------|-----------------------|------|
| NPN | PNP | | | @ | | @ | | | |
| 0.3 Amp | | | | | | | | | |
| MJ205 | | 750 | 2/- | 2.5 | 5.0 | 2.5 | 7.5 | 10 | 11 |
| BU205 | | 750 | 2/- | 2.5 | 5.0 | 2.5 | 7.5 | 10 | 11 |
| 3.0 Amp | | | | | | | | | |
| MJE520 | | 30 | 25/- | 1.0 | | | | 25 | 77 |
| MJE31 | MJE32 | 40 | 25/- | 1.0 | 1.2 | 3.0 | 3.0 | 40 | 77 |
| 2N4921 | 2N4918 | 40 | 20/100 | 0.5 | 0.6 | 1.0 | 3.0 | 30 | 77 |
| | 2N3867 | 40 | 40/200 | 1.5 | 0.75 | 1.5 | 60 | 6.0 | 31 |
| | 2N3868 | 60 | 30/150 | 1.5 | 0.75 | 1.5 | 60 | 6.0 | 31 |
| | 2N4919 | 50 | 20/100 | 0.5 | 0.6 | 1.0 | 3.0 | 30 | 77 |
| | MJ2253 | 60 | 20/100 | 0.25 | 0.3 | 0.5 | 3.0 | 25 | 80 |
| 2N4922 | MJE32A | 60 | 25/- | 1.0 | 1.2 | 3.0 | 3.0 | 40 | 77 |
| MJE31A | MJE32B | 80 | 25/- | 1.0 | 1.2 | 3.0 | 3.0 | 40 | 77 |
| MJE31B | MJ2254 | 60 | 20/100 | 0.25 | 0.3 | 0.5 | 3.0 | 25 | 80 |
| 2N6416 | 2N6418 | 90 | 40/250 | 0.2 | 3.0 | 3.0 | 40 | 15 | 77 |
| 2N4923 | 2N4920 | 60 | 20/100 | 0.5 | 0.6 | 1.0 | 3.0 | 30 | 77 |
| 2N6417 | 2N6419 | 100 | 40/250 | 0.2 | 3.0 | 3.0 | 40 | 15 | 77 |
| MJE31C | MJE32C | 100 | 25/- | 1.0 | 1.2 | 3.0 | 3.0 | 40 | 77 |
| 3.5 Amp | | | | | | | | | |
| 2N3902 | | 400 | 30/90 | 1.0 | 0.6 | 1.0 | 2.8 | 100 | 11 |
| 4.0 Amp | | | | | | | | | |
| 2N6410 | 2N6411 | 25 | 45/180 | 2.0 | 0.8 | 2.0 | 50 | 15 | 77 |
| 2N6412 | 2N6414 | 40 | 40/250 | 0.2 | 2.5 | 4.0 | 50 | 15 | 77 |
| 2N5190 | 2N5193 | 40 | 25/100 | 1.5 | 0.6 | 1.5 | 2.0 | 40 | 77 |
| MJE5190 | MJE5193 | 40 | 25/100 | 1.5 | 0.6 | 1.5 | 2.0 | 60 | 199 |
| 2N6037 | 2N6034 | 40 | 750/15k | 2.0 | 2.0 | 2.0 | 25 | 40 | 77 |
| MJE3300 | MJE3310 | 40 | 1000/- | 1.0 | 1.5 | 1.5 | 20 | 15 | 77 |
| 2N3054A | 2N6049 | 55 | 25/100 | 0.5 | 1.0 | 0.5 | 3.0 | 75 | 80 |
| 2N6413 | 2N6415 | 60 | 40/250 | 0.2 | 2.5 | 4.0 | 50 | 15 | 77 |
| 2N5191 | 2N5194 | 60 | 25/100 | 1.5 | 0.8 | 1.5 | 2.0 | 40 | 77 |
| MJE5191 | MJE5194 | 60 | 25/100 | 1.5 | 0.6 | 1.5 | 2.0 | 60 | 199 |
| | 2N3740 | 60 | 30/100 | 0.25 | 0.6 | 1.0 | 4.0 | 25 | 80 |
| 2N6294 | 2N6296 | 60 | 750/18k | 2.0 | 2.0 | 2.0 | 4.0 | 50 | 60 |
| 2N6038 | 2N6035 | 60 | 750/15k | 2.0 | 2.0 | 2.0 | 25 | 40 | 77 |
| MJE3301 | MJE3311 | 60 | 1000/- | 1.0 | 1.5 | 1.5 | 20 | 15 | 77 |
| MJE800 | MJE700 | 60 | 750/- | 1.5 | 2.5 | 1.5 | 40 | 77 | 77 |
| MJE3302 | MJE3312 | 80 | 1000/- | 1.0 | 1.5 | 1.5 | 20 | 15 | 77 |
| 2N5192 | 2N5195 | 60 | 20/80 | 1.5 | 0.8 | 1.5 | 2.0 | 40 | 77 |
| MJE5192 | MJE5195 | 80 | 20/60 | 1.5 | 0.6 | 1.5 | 2.0 | 80 | 199 |
| | 2N3741 | 60 | 30/100 | 0.25 | 0.6 | 1.0 | 4.0 | 25 | 80 |
| 2N6295 | 2N6297 | 80 | 750/18k | 2.0 | 2.0 | 2.0 | 4.0 | 50 | 80 |
| 2N6039 | 2N6036 | 80 | 750/15k | 2.0 | 2.0 | 2.0 | 25 | 40 | 77 |

SILICON POWER TRANSISTORS (Continued)

REFERRED SILICON POWER TRANSISTORS (continued)

| Device and Polarity | | V _{CEO} Volts Max | h _{FE} Min/Max | I _C Amp | V _{CE(sat)} Volts Max | I _C Amp | f _T MHz | P _D Watts Max | Case |
|---------------------|---------|----------------------------------|----------------------------|-----------------------|--------------------------------------|-----------------------|-----------------------|--------------------------------|------|
| NPN | PNP | | | @ | | @ | Min | | |
| 5.0 Amp | | | | | | | | | |
| MJE200 | MJE210 | 25 | 45/180 | 2.0 | 0.75 | 2.0 | 65 | 15 | 77 |
| 2N4231A | 2N6312 | 40 | 25/100 | 1.5 | 0.7 | 1.5 | 4.0 | 75 | 80 |
| MJE5977 | MJE5974 | 40 | 20/120 | 2.5 | 0.6 | 2.5 | 2.0 | 75 | 199 |
| 2N4232A | 2N6313 | 60 | 25/100 | 1.5 | 0.7 | 1.5 | 4.0 | 75 | 80 |
| MJE5978 | MJE5975 | 60 | 20/120 | 2.5 | 0.8 | 2.5 | 2.0 | 75 | 199 |
| 2N4233A | 2N6314 | 80 | 20/120 | 1.5 | 0.7 | 1.5 | 4.0 | 75 | 199 |
| MJE1100 | MJE1090 | 80 | 750/- | 3.0 | 2.5 | 3.0 | | 90 | |
| MJE5979 | MJE5976 | 80 | 20/120 | 2.5 | 0.6 | 2.5 | 2.0 | 75 | 199 |
| 2N6233 | | 225 | 25/125 | 1.0 | 1.0 | 1.0 | 20 | 50 | 80 |
| 2N6497 | | 250 | 10/75 | 2.5 | 1.5 | 2.5 | 5.0 | 80 | 199 |
| MJE51 | | 250 | 5.0/- | 5.0 | 2.0 | 5.0 | 2.5 | 80 | 199 |
| 2N6234 | | 275 | 25/125 | 1.0 | 0.5 | 1.0 | 20 | 50 | 80 |
| 2N6542 | | 300 | 7/35 | 3.0 | 1.0 | 3.0 | 6.0 | 100 | 11 |
| 2N6498 | | 300 | 10/75 | 2.5 | 1.5 | 2.5 | 5.0 | 80 | 199 |
| MJE52 | | 300 | 5.0/- | 5.0 | 2.0 | 5.0 | 2.5 | 80 | 199 |
| 2N6235 | | 325 | 25/125 | 1.0 | 0.5 | 1.0 | 20 | 50 | 80 |
| 2N6499 | | 350 | 10/75 | 2.5 | 1.5 | 2.5 | 5.0 | 80 | 199 |
| MJE53 | | 350 | 5.0/- | 5.0 | 2.0 | 5.0 | 2.5 | 80 | 199 |
| MJ425 | | 400 | 90/90 | 1.0 | 0.8 | 1.0 | 2.5 | 100 | 11 |
| 2N6543 | | 400 | 7/35 | 3.0 | 1.0 | 3.0 | 6.0 | 100 | 11 |
| BU106 | | 750 | | | 5.0 | 4.5 | 7.5 | 55 | 11 |
| MJ804 | | 800 | 2.2/- | 3.5 | | | 1.5 | 100 | 11 |
| 6.0 Amp | | | | | | | | | |
| MJE41 | MJE42 | 40 | 30/- | 0.3 | 1.5 | 6.0 | 2.0 | 65 | 199 |
| MJE41A | MJE42A | 80 | 30/- | 0.3 | 1.5 | 6.0 | 2.0 | 65 | 199 |
| MJE41B | MJE42B | 80 | 30/- | 0.3 | 1.5 | 6.0 | 2.0 | 65 | 199 |
| MJE41C | MJE42C | 100 | 30/- | 0.3 | 1.5 | 6.0 | 2.0 | 65 | 199 |
| 2N5758 | 2N6226 | 100 | 25/100 | 3.0 | 1.0 | 3.0 | 1.0 | 150 | 11 |
| 2N5759 | 2N6227 | 120 | 20/90 | 3.0 | 1.0 | 3.0 | 1.0 | 150 | 11 |
| 2N5760 | 2N6228 | 140 | 15/80 | 3.0 | 1.0 | 3.0 | 1.0 | 150 | 11 |
| MJ3760 | | 550 | | | 5.0 | 6.0 | 7.5 | 80 | 11 |
| 8.0 Amp | | | | | | | | | |
| MJE5983 | MJE5980 | 40 | 20/120 | 4.0 | 0.6 | 4.0 | 2.0 | 90 | 199 |
| MJE5984 | MJE5981 | 60 | 20/120 | 4.0 | 0.5 | 4.0 | 2.0 | 90 | 199 |
| 2N6300 | 2N6298 | 60 | 750/18k | 4.0 | 2.0 | 4.0 | 4.0 | 75 | 80 |
| 2N6355 | 2N6053 | 80 | 750/18k | 4.0 | 2.0 | 4.0 | 4.0 | 100 | 11 |
| 2N6043 | 2N6040 | 80 | 1k/20k | 4.0 | 2.0 | 4.0 | 4.0 | 75 | 199 |
| MJ1300 | MJ900 | 60 | 1k/- | 3.0 | 2.0 | 3.0 | | 90 | 11 |
| MJE5985 | MJE5982 | 80 | 20/120 | 4.0 | 0.6 | 4.0 | 2.0 | 90 | 199 |
| 2N6301 | 2N6299 | 80 | 750/16k | 4.0 | 2.0 | 4.0 | 4.0 | 75 | 80 |
| 2N6056 | 2N6054 | 80 | 750/18k | 4.0 | 2.0 | 4.0 | 4.0 | 100 | 11 |
| 2N6044 | 2N6041 | 80 | 1k/20k | 4.0 | 2.0 | 4.0 | 4.0 | 75 | 199 |
| 2N6045 | 2N6042 | 100 | 1k/20k | 3.0 | 2.0 | 4.0 | 4.0 | 75 | 199 |
| 2N6306 | | 250 | 15/75 | 3.0 | 0.8 | 3.0 | 5.0 | 125 | 11 |
| 2N6307 | | 300 | 15/75 | 3.0 | 1.0 | 3.0 | 5.0 | 125 | 11 |
| MJ7160 | | 300 | 25/100 | 3.0 | 1.0 | 3.0 | 30 | 140 | 11 |
| 2N6544 | | 300 | 7/35 | 5.0 | 1.5 | 5.0 | 6.0 | 125 | 11 |
| 2N6308 | | 350 | 12/60 | 3.0 | 5.0 | 1.5 | 3.0 | 125 | 11 |
| MJ7161 | | 400 | 25/100 | 3.0 | 1.0 | 3.0 | 30 | 140 | 11 |
| 2N6545 | | 400 | 7/35 | 5.0 | 1.5 | 5.0 | 6.0 | 125 | 11 |
| MJ3761 | | 550 | | | 5.0 | 8.0 | 7.5 | 80 | 11 |

SILICON POWER TRANSISTORS (Continued)

PREFERRED SILICON POWER TRANSISTORS (continued)

| Device and Polarity | | V _{CEO} Volts Max | h _{FE} Min/Max | I _C @ Amp | V _{CE (sat)} Volts Max | I _C @ Amp | f _T MHz Min | P _D Watts Max | Case |
|---------------------|----------|----------------------------------|----------------------------|----------------------------|---------------------------------------|----------------------------|------------------------------|--------------------------------|------|
| NPN | | PNP | | | | | | | |
| 10 Amp | | | | | | | | | |
| 2N5304 | | 40 | 30/120 | 2.0 | 0.4 | 2.0 | 100 | 25 | 9 |
| MJE33 | MJE34 | 40 | 40/- | 1.0 | 1.0 | 3.0 | 2.0 | 60 | 199 |
| 2N6383 | | 40 | 1k/20k | 5.0 | 2.0 | 5.0 | 20 | 100 | 11 |
| 2N6384 | | 60 | 1k/20k | 5.0 | 2.0 | 5.0 | 20 | 100 | 11 |
| MJE3055 | MJE2955 | 60 | 20/70 | 4.0 | 1.1 | 4.0 | 2.0 | 60 | 60 |
| MJE3055K | MJE2955K | 60 | 20/70 | 4.0 | 1.1 | 4.0 | 2.0 | 60 | 199 |
| 2N5877 | 2N5875 | 60 | 20/100 | 4.0 | 1.0 | 5.0 | 4.0 | 150 | 11 |
| 2N3715 | 2N3791 | 60 | 50/150 | 1.0 | 0.8 | 5.0 | 4.0 | 150 | 11 |
| MJE33A | MJE34A | 60 | 40/- | 1.0 | 1.0 | 3.0 | 2.0 | 60 | 199 |
| 2N5878 | 2N5876 | 60 | 20/100 | 4.0 | 1.0 | 5.0 | 4.0 | 150 | 11 |
| 2N6385 | | 60 | 1k/20k | 5.0 | 2.0 | 5.0 | 20 | 100 | 11 |
| 2N3716 | 2N3792 | 60 | 50/150 | 1.0 | 0.8 | 5.0 | 4.0 | 150 | 11 |
| MJE338 | MJE348 | 80 | 40/- | 1.0 | 1.0 | 3.0 | 2.0 | 60 | 199 |
| MJE33C | MJE34C | 100 | 40/- | 1.0 | 1.0 | 3.0 | 2.0 | 80 | 199 |
| 2N5632 | 2N6229 | 100 | 25/100 | 5.0 | 1.0 | 7.5 | 1.0 | 150 | 11 |
| 2N5633 | 2N6230 | 120 | 20/60 | 5.0 | 1.0 | 7.5 | 1.0 | 150 | 11 |
| 2N5634 | 2N6231 | 140 | 15/60 | 5.0 | 1.0 | 7.5 | 1.0 | 150 | 11 |
| MJ413 | | 325 | 20/60 | 0.5 | 0.8 | 0.5 | 2.5 | 125 | 11 |
| MJ423 | | 325 | 30/60 | 1.0 | 0.8 | 1.0 | 2.5 | 125 | 11 |
| 12 Amp | | | | | | | | | |
| 2N6569 | | 40 | 15/200 | 4.0 | 1.5 | 4.0 | 1.5 | 100 | 11 |
| 2N5989 | 2N5986 | 40 | 20/120 | 8.0 | 0.7 | 6.0 | 2.0 | 100 | 90 |
| 2N5990 | 2N5987 | 60 | 20/120 | 6.0 | 0.7 | 6.0 | 2.0 | 100 | 60 |
| 2N6057 | 2N6050 | 60 | 750/18k | 8.0 | 2.0 | 6.0 | 4.0 | 150 | 11 |
| 2N5991 | 2N5988 | 60 | 20/120 | 8.0 | 0.7 | 6.0 | 2.0 | 100 | 90 |
| 2N6058 | 2N6051 | 60 | 750/18k | 8.0 | 2.0 | 6.0 | 4.0 | 150 | 11 |
| 2N6059 | 2N6052 | 100 | 750/18k | 6.0 | 2.0 | 6.0 | 4.0 | 150 | 11 |
| 15 Amp | | | | | | | | | |
| 2N3055 | | 60 | 20/70 | 4.0 | 1.1 | 4.0 | 2.5 | 115 | 11 |
| | MJ2955 | 60 | 20/70 | 4.0 | 1.1 | 4.0 | 4.0 | 150 | 11 |
| 2N5881 | 2N5879 | 80 | 20/100 | 8.0 | 1.0 | 7.0 | 4.0 | 160 | 11 |
| 2N6576 | | 60 | 500/5k | 10 | 4.0 | 15 | | 120 | 11 |
| 2N5882 | 2N5880 | 60 | 20/100 | 8.0 | 1.0 | 7.0 | 4.0 | 160 | 11 |
| 2N6577 | | 60 | 500/5k | 10 | 4.0 | 15 | | 120 | 11 |
| 2N6578 | | 120 | 500/5k | 10 | 4.0 | 15 | | 120 | 11 |
| 2N6249 | | 200 | 10/50 | 10 | 1.5 | 10 | 2.5 | 175 | 11 |
| 2N6250 | | 275 | 6.0/50 | 10 | 1.5 | 10 | 2.5 | 175 | 11 |
| MJ7260 | | 300 | 25/100 | 5.0 | 1.0 | 5.0 | 30 | 175 | 11 |
| 2N6546 | | 300 | 6/35 | 10 | 1.5 | 10 | 8.0 | 175 | 11 |
| 2N6251 | | 350 | 6.0/50 | 10 | 1.5 | 10 | 2.5 | 175 | 11 |
| MJ7261 | | 400 | 25/100 | 5.0 | 1.0 | 5.0 | 30 | 175 | 11 |
| 2N6547 | | 400 | 6/35 | 10 | 1.5 | 10 | 8.0 | 175 | 11 |
| 16 Amp | | | | | | | | | |
| 2N5629 | 2N6029 | 100 | 25/100 | 8.0 | 1.0 | 10 | 1.0 | 200 | 11 |
| 2N5630 | 2N6030 | 120 | 20/80 | 8.0 | 1.0 | 10 | 1.0 | 200 | 11 |
| 2N5631 | 2N6031 | 140 | 15/60 | 8.0 | 1.0 | 10 | 1.0 | 200 | 11 |
| 20 Amp | | | | | | | | | |
| 2N6282 | 2N6285 | 60 | 750/18k | 10 | 2.0 | 10 | 4.0 | 180 | 11 |
| 2N5303 | 2N5745 | 80 | 15/60 | 10 | 1.0 | 10 | 2.0 | 200 | 12 |
| 2N6283 | 2N6286 | 60 | 750/18k | 10 | 2.0 | 10 | 4.0 | 180 | 11 |
| 2N6284 | 2N6287 | 100 | 750/18k | 10 | 2.0 | 10 | 4.0 | 180 | 11 |

SILICON POWER TRANSISTORS (Continued)

REFERRED SILICON POWER TRANSISTORS (continued)

| Device and Polarity | | V_{CE0} Volts Max | h_{FE} Min/Max | I_C Amp | $V_{CE(sat)}$ Volts Max | I_C Amp | f_T MHz Min | P_D Watts Max | Case |
|---------------------|--------|---------------------------|---------------------|--------------|-------------------------------|--------------|---------------------|-----------------------|------|
| NPN | PNP | | | | | | | | |
| 25 Amp | | | | | | | | | |
| 2N5885 | 2N5883 | 60 | 20/100 | 10 | 1.0 | 15 | 4.0 | 200 | 11 |
| | 2N6436 | 80 | 20/80 | 10 | 1.0 | 10 | 40 | 200 | 11 |
| 2N5886 | 2N5884 | 80 | 20/100 | 10 | 1.0 | 15 | 4.0 | 200 | 11 |
| | 2N6437 | 100 | 20/80 | 10 | 1.0 | 10 | 40 | 200 | 11 |
| 2N6338 | | 100 | 30/120 | 10 | 1.0 | 10 | 40 | 200 | 11 |
| | 2N6438 | 120 | 20/80 | 10 | 1.0 | 10 | 40 | 200 | 11 |
| 2N6339 | | 120 | 30/120 | 10 | 1.0 | 10 | 40 | 200 | 11 |
| 2N6340 | | 140 | 30/120 | 10 | 1.0 | 10 | 40 | 200 | 11 |
| 2N6341 | | 150 | 30/120 | 10 | 1.0 | 10 | 40 | 200 | 11 |
| 30 Amp | | | | | | | | | |
| 2N5301 | 2N4398 | 40 | 15/60 | 15 | 3.0 | 0.75 | 10 | 200 | 12 |
| 2N5302 | 2N4399 | 60 | 15/60 | 15 | 2.0 | 0.75 | 10 | 200 | 12 |
| MJ802 | MJ4502 | 90 | 25/100 | 7.5 | 0.8 | 7.5 | 2.0 | 200 | 12 |
| 50 Amp | | | | | | | | | |
| 2N5685 | 2N5683 | 60 | 15/60 | 25 | 1.0 | 25 | 2.0 | 300 | 197 |
| 2N5686 | 2N5684 | 80 | 15/60 | 25 | 1.0 | 25 | 2.0 | 300 | 197 |
| | 2N6377 | 80 | 30/120 | 20 | 1.2 | 20 | 30 | 250 | 197 |
| | 2N6378 | 100 | 30/120 | 20 | 1.2 | 20 | 30 | 250 | 197 |
| 2N6274 | | 100 | 30/120 | 20 | 1.0 | 20 | 30 | 250 | 197 |
| | 2N6379 | 120 | 30/120 | 20 | 1.2 | 20 | 30 | 250 | 197 |
| 2N6275 | | 120 | 30/120 | 20 | 1.0 | 20 | 30 | 250 | 197 |
| 2N6276 | | 140 | 30/120 | 20 | 1.0 | 20 | 30 | 250 | 197 |
| 2N6277 | | 150 | 30/120 | 20 | 1.0 | 20 | 30 | 250 | 197 |

Power SWITCHMODE Transistors

The Designers data sheets for switchmode silicon power devices provide detailed information for operating conditions as well as safety limits. Voltage, current, switching, temperature and secondary breakdown requirements are specified in detail.

The 2N6542 thru 2N6547 transistors are designed for high-voltage, high-speed, power switching in inductive circuits where fall time is critical. They are particularly suited for 115 and 220 volt line operated switch-mode applications such as:

- Switching Regulators
- PWM Inverters and Motor Controls
- Solenoid and Relay Drivers
- Deflection Circuits

Specification Features —

High Temperature Performance Specified for:

Reversed Biased SOA with Inductive Loads

Switching Times with Inductive Loads

Saturation Voltages

Leakage Currents

The device types are listed in increasing order of I_C continuous and V_{CEV} rating.

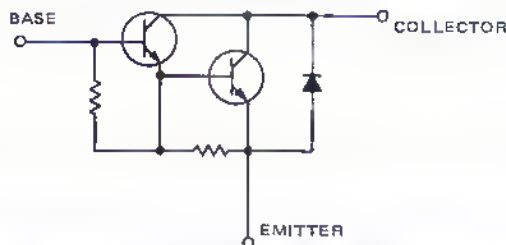
| Device | I_C Amp Max | V_{CEV} Volts Max | $V_{CE(sat)}$ @ 100°C Volts Min | $V_{CE(sat)}$ @ 100°C Volts Max | I_C Amp | t_f @ 100°C ns Max | I_C Amp |
|------------|---------------------|---------------------------|--|--|--------------|-------------------------------|--------------|
| NPN | | | | | | | |
| 2N6542 | 5.0 | 650 | 350 | 2.0 | 3.0 | 800 | 3.0 |
| 2N6543 | 5.0 | 850 | 450 | 2.0 | 3.0 | 800 | 3.0 |
| 2N6544 | 8.0 | 650 | 350 | 2.5 | 5.0 | 900 | 5.0 |
| 2N6545 | 8.0 | 850 | 450 | 2.5 | 5.0 | 900 | 5.0 |
| 2N6546 | 15 | 650 | 350 | 2.5 | 10 | 1500 | 10 |
| 2N6547 | 15 | 850 | 450 | 2.5 | 10 | 1500 | 10 |

Power Darlington Transistors

Monolithic power Darlington devices have found wide design usage in a variety of different applications. This power technology promises an even brighter future in advancing the state of the art — high voltage and very high current devices are on the horizon and will soon become a viable alternative to Thyristor devices on the designer's specification list. Darlington devices are not only a very high gain alternative; other significant advantages include:

- integrated circuit compatibility
- high input impedance
- high current gain
- reduced component count
- space savings

The following devices are listed in increasing order of I_C continuous and V_{CEO} rating.



| Device and Polarity | | I_C Amp Max | V_{CEO} Volts Max | h_{FE} Min/Max | @ I_C Amp | $V_{CE(sat)}$ Volts Max | @ I_C Amp | f_T MHz Min | P_D Watts Max | Case |
|---------------------|---------|---------------------|---------------------------|---------------------|-------------------|-------------------------------|-------------------|---------------------|-----------------------|------|
| NPN | PNP | | | | | | | | | |
| 2N6037 | 2N6034 | 4.0 | 40 | 750/15k | 2.0 | 2.0 | 2.0 | 25 | 40 | 77 |
| 2N6294 | 2N6298 | 4.0 | 60 | 750/18k | 2.0 | 2.0 | 2.0 | 4.0 | 50 | 80 |
| 2N6038 | 2N6035 | 4.0 | 60 | 750/15k | 2.0 | 2.0 | 2.0 | 25 | 40 | 77 |
| MJE800 | MJE700 | 4.0 | 60 | 750/- | 1.5 | 2.5 | 1.5 | | 40 | 77 |
| 2N6295 | 2N6297 | 4.0 | 80 | 750/18k | 2.0 | 2.0 | 2.0 | 4.0 | 50 | 80 |
| 2N6039 | 2N6036 | 4.0 | 80 | 750/15k | 2.0 | 2.0 | 2.0 | 25 | 40 | 77 |
| MJE3300 | MJE3310 | 4.0 | 40 | 1k/- | 1.0 | 1.5 | 1.5 | 20 | 15 | 77 |
| MJE3301 | MJE3311 | 4.0 | 80 | 1k/- | 1.0 | 1.5 | 1.5 | 20 | 15 | 77 |
| MJE3302 | MJE3312 | 4.0 | 80 | 1k/- | 1.0 | 1.5 | 1.5 | 20 | 15 | 77 |
| MJE1100 | MJE1090 | 5.0 | 60 | 750/- | 3.0 | 2.5 | 3.0 | 1.0 | 70 | 90 |
| MJ1000 | MJ900 | 8.0 | 80 | 1k/- | 3.0 | 2.0 | 3.0 | | 90 | 11 |
| 2N6300 | 2N6298 | 8.0 | 60 | 750/18k | 4.0 | 2.0 | 4.0 | 4.0 | 75 | 80 |
| 2N6055 | 2N6053 | 8.0 | 60 | 750/18k | 4.0 | 2.0 | 4.0 | 4.0 | 100 | 11 |
| 2N6043 | 2N6040 | 8.0 | 60 | 1k/20k | 4.0 | 2.0 | 4.0 | 4.0 | 75 | 199 |
| 2N6301 | 2N6299 | 8.0 | 60 | 750/18k | 4.0 | 2.0 | 4.0 | 4.0 | 75 | 80 |
| 2N8056 | 2N6054 | 8.0 | 80 | 750/18k | 4.0 | 2.0 | 4.0 | 4.0 | 100 | 11 |
| 2N6044 | 2N6041 | 8.0 | 80 | 1k/20k | 4.0 | 2.0 | 4.0 | 4.0 | 75 | 199 |
| 2N6045 | 2N6042 | 8.0 | 100 | 1k/20k | 3.0 | 2.0 | 4.0 | 4.0 | 75 | 199 |
| 2N6057 | 2N6050 | 12 | 60 | 750/16k | 6.0 | 2.0 | 6.0 | 4.0 | 150 | 11 |
| 2N6058 | 2N6051 | 12 | 80 | 750/18k | 6.0 | 2.0 | 8.0 | 4.0 | 150 | 11 |
| 2N6059 | 2N6052 | 12 | 100 | 750/18k | 6.0 | 2.0 | 6.0 | 4.0 | 150 | 11 |
| 2N6576 | | 15 | 60 | 500/5k | 10 | 2.8 | 10 | 4.0 | 120 | 11 |
| 2N6577 | | 15 | 60 | 500/5k | 10 | 2.8 | 10 | 4.0 | 120 | 11 |
| 2N6578 | | 15 | 120 | 500/5k | 10 | 2.8 | 10 | 4.0 | 120 | 11 |
| 2N6282 | 2N6285 | 20 | 80 | 750/16k | 10 | 2.0 | 10 | 4.0 | 160 | 11 |
| 2N6283 | 2N6286 | 20 | 80 | 750/18k | 10 | 2.0 | 10 | 4.0 | 160 | 11 |
| 2N6284 | 2N6287 | 20 | 100 | 750/18k | 10 | 2.0 | 10 | 4.0 | 160 | 11 |

High Voltage Transistors

The high-voltage devices are intended for industrial, commercial and military equipment. Typical applications include high-voltage differential and operational amplifiers, high-voltage inverters, low and medium current switching and series regulators. The devices are listed in decreasing order of V_{CE0} and I_C continuous.

| Device and Polarity | I_C Amp Max | h_{FE} Min/Max | @ I_C Amp | V_{CE0} (sat) Volts Max | @ I_C Amp | f_T MHz Min | P_D Watts Max | Case |
|---------------------|---------------------|---------------------|-------------------|---------------------------------|-------------------|---------------------|-----------------------|------|
| NPN | PNP | | | | | | | |
| 800 Volts | | | | | | | | |
| MJ804 | | 5.0 | 2.2/- | 3.5 | | 1.5 | 100 | 11 |
| 750 Volts | | | | | | | | |
| 8U108 | | 5.0 | | | 5.0 | 4.5 | 7.5 | 11 |
| 8U208 | | 5.0 | | | 5.0 | 4.5 | 7.5 | 11 |
| MJ205 | | 2.5 | 2/- | 2.5 | 5.0 | 2.5 | 7.5 | 11 |
| 8U205 | | 2.5 | 2/- | 2.5 | 5.0 | 2.5 | 7.5 | 11 |
| 550 Volts | | | | | | | | |
| MJ3780 | | 8.0 | | | 5.0 | 8.0 | 7.5 | 11 |
| MJ3761 | | 6.0 | | | 5.0 | 8.0 | 7.5 | 11 |
| 400 Volts | | | | | | | | |
| MJ7261 | | 15 | 25/100 | 5.0 | 1.0 | 5.0 | 00 | 11 |
| 2N6547 | | 15 | 6/35 | 10 | 1.5 | 10 | 6.0 | 11 |
| MJ7161 | | 8.0 | 25/100 | 3.0 | 1.0 | 3.0 | 175 | 11 |
| 2N6545 | | 8.0 | 7/35 | 5.0 | 1.5 | 5.0 | 140 | 11 |
| 2N6543 | | 5.0 | 7/35 | 3.0 | 1.0 | 3.0 | 125 | 11 |
| MJ425 | | 5.0 | 30/90 | 1.0 | 0.8 | 1.0 | 100 | 11 |
| 2N3902 | | 3.5 | 30/90 | 1.0 | 0.8 | 1.0 | 100 | 11 |
| 350 Volts | | | | | | | | |
| 2N6251 | | 15 | 6.0/50 | 10 | 1.5 | 10 | 175 | 11 |
| 2N6308 | | 8.0 | 12/80 | 3.0 | 5.0 | 1.5 | 125 | 11 |
| 2N6499 | | 5.0 | 10/75 | 2.5 | 1.5 | 2.5 | 80 | 199 |
| MJE53 | | 5.0 | 30/- | 0.3 | 2.0 | 5.0 | 2.5 | 199 |
| MJE49 | | 1.5 | 30/250 | 0.3 | 1.0 | 1.0 | 80 | 199 |
| 2N3439 | | 1.0 | 40/160 | 0.02 | 0.5 | 0.05 | 50 | 199 |
| MJE5657 | | 0.5 | 30/250 | 0.1 | 1.0 | 0.1 | 15 | 79 |
| 2N6557 | | 0.5 | 30/250 | 0.1 | 1.0 | 0.1 | 30 | 199 |
| MJE3439 | | 0.3 | 40/180 | 0.02 | 0.5 | 0.05 | 10 | 77 |
| 325 Volts | | | | | | | | |
| MJ423 | | 10 | 30/90 | 1.0 | 0.8 | 1.0 | 125 | 11 |
| MJ413 | | 10 | 20/80 | 0.5 | 0.8 | 0.5 | 125 | 11 |
| 2N6235 | | 5.0 | 25/125 | 1.0 | 0.5 | 1.0 | 50 | 80 |
| 300 Volts | | | | | | | | |
| MJ7260 | | 15 | 25/100 | 5.0 | 1.0 | 5.0 | 175 | 11 |
| 2N6546 | | 15 | 6/35 | 10 | 1.5 | 10 | 175 | 11 |
| 2N6307 | | 8.0 | 15/75 | 3.0 | 1.0 | 3.0 | 125 | 11 |
| MJ7180 | | 8.0 | 25/100 | 3.0 | 1.0 | 3.0 | 140 | 11 |
| 2N6544 | | 8.0 | 7/35 | 5.0 | 1.5 | 5.0 | 125 | 11 |
| MJE52 | | 5.0 | 30/- | 0.3 | 2.0 | 5.0 | 80 | 199 |
| 2N6542 | | 5.0 | 7/35 | 3.0 | 1.0 | 3.0 | 100 | 11 |
| 2N6498 | | 5.0 | 10/75 | 2.5 | 1.5 | 2.5 | 80 | 199 |
| 2N3585 | 2N6422 | 2.0 | 8/80 | 1.0 | 0.75 | 1.0 | 35 | 80 |
| 2N4240 | 2N6423 | 2.0 | 10/100 | 0.75 | 1.0 | 0.75 | 15 | 80 |
| MJE48 | | 1.5 | 30/250 | 0.3 | 1.0 | 1.0 | 35 | 80 |
| MJE2160 | | 1.5 | 30/240 | 0.5 | 3.5 | 0.5 | 50 | 199 |
| 2N3739 | 2N6425 | 1.0 | 40/200 | 0.1 | 2.5 | 0.25 | 10 | 80 |
| | MJ5416 | 1.0 | 30/120 | 0.05 | 2.5 | 0.05 | 15 | 79 |
| 2N5856 | | 0.5 | 30/250 | 0.1 | 1.0 | 0.1 | 10 | 77 |
| MJE5656 | | 0.5 | 00/250 | 0.1 | 1.0 | | 30 | 199 |
| MJE340K | | 0.5 | 30/240 | 0.05 | | | 30 | 199 |
| MJE340 | MJE350 | 0.5 | 30/240 | 0.05 | | | 20 | 77 |

SILICON POWER TRANSISTORS (Continued)

HIGH VOLTAGE TRANSISTORS (continued)

| Device and Polarity | | I_C Amp Max | h_{FE} Min/Max | @ | I_C Amp | $V_{CE(sat)}$ Volts Max | @ | I_C Amp | f_T MHz Min | P_D Watts Max | Case |
|---------------------|--------|---------------------|---------------------|---|--------------|-------------------------------|---|--------------|---------------------|-----------------------|------|
| NPN | | | | | | | | | | | |
| PNP | | | | | | | | | | | |
| 275 Volts | | | | | | | | | | | |
| 2N6250 | | 15 | 8.0/50 | | 10 | 1.5 | | 10 | 2.5 | 175 | 11 |
| 2N6234 | | 5.0 | 25/125 | | 1.0 | 0.6 | | 1.0 | 20 | 50 | 80 |
| 250 Volts | | | | | | | | | | | |
| 2N6305 | | 8.0 | 15/75 | | 3.0 | 0.8 | | 3.0 | 5.0 | 125 | 11 |
| 2N6497 | | 5.0 | 10/75 | | 2.5 | 1.5 | | 2.5 | 5.0 | 60 | 199 |
| MJE51 | | 5.0 | 30/- | | 0.3 | 2.0 | | 5.0 | 2.5 | 80 | 199 |
| 2N3584 | 2N6421 | 2.0 | 8.0/60 | | 1.0 | 0.75 | | 1.0 | 10 | 35 | 80 |
| MJE47 | | 1.5 | 30/250 | | 0.3 | 1.0 | | 1.0 | 5.0 | 50 | 199 |
| 2N3440 | | 1.0 | 40/160 | | 0.02 | 0.5 | | 0.05 | 15 | 5.0 | 79 |
| 2N5655 | | 0.5 | 30/250 | | 0.1 | 1.0 | | 0.1 | 10 | 20 | 77 |
| MJE655 | | 0.5 | 30/250 | | 0.1 | 1.0 | | 0.1 | 10 | 30 | 199 |
| MJE3440 | | 0.3 | 40/160 | | 0.02 | 0.5 | | 0.05 | 15 | 15 | 77 |
| 225 Volts | | | | | | | | | | | |
| 2N6233 | | 5.0 | 25/125 | | 1.0 | 1.0 | | 1.0 | 20 | 50 | 60 |
| 2N3738 | 2N6424 | 1.0 | 40/200 | | 0.1 | 2.5 | | 0.25 | 10 | 20 | 60 |
| 200 Volts | | | | | | | | | | | |
| 2N6249 | | 15 | 10/50 | | 10 | 1.5 | | 10 | 2.5 | 175 | 11 |
| | MJ5415 | 1.0 | 30/150 | | 0.05 | 2.5 | | 0.05 | 15 | 10 | 79 |

High Power Voltage Regulators

The MPC1000 and MPC900 are complete solid state hybrid regulators in a metal hermetic package. Specifications and performance of the MPC1000 positive voltage regulator and the MPC900 negative voltage regulator are nearly identical.

For systems requiring both a positive and a negative power supply, these devices are excellent for use as complementary regulators and offer the advantage of operation with a common ground. The devices are designed to deliver load current to 10 A dc. Output current capability can be increased further through use of one or more external pass transistors. They are specified for operation over the junction temperature range (-55 to +175°C).

| Device and Polarity | | V_O Volts | | I_L A Max | $V_{in} - V_O$ Volts | | V_{in} Volts | | I_{in} mA Max | Reg. % V_O/V_{in} Max | Reg. % V_O Max | P_D Watts Max | Case |
|---------------------|--------|----------------|-----|-------------------|-------------------------|-----|-------------------|-----|-----------------------|-------------------------------|------------------------|-----------------------|--------|
| NPN | | Min | Max | | Min | Max | Min | Max | | | | | |
| PNP | | | | | | | | | | | | | |
| MPC1000 | | 2.0 | 35 | 10 | 3.0 | 60 | 9.5 | 40 | 5.0 | 0.5 | 0.6 | 100 | 662-01 |
| | MPC900 | -4.0 | -30 | 10 | 2.5 | 30 | -9.0 | -35 | 20 | 0.5 | 0.6 | 100 | 662-01 |

High Frequency Transistors

The following high-frequency devices are intended for a wide variety of power amplifier and high-speed saturated switching applications. With minimum gain-bandwidth products (f_T) up to 100 MHz, these devices provide useful gain at high frequencies. The device types are listed in order of decreasing f_T and increasing I_C continuous.

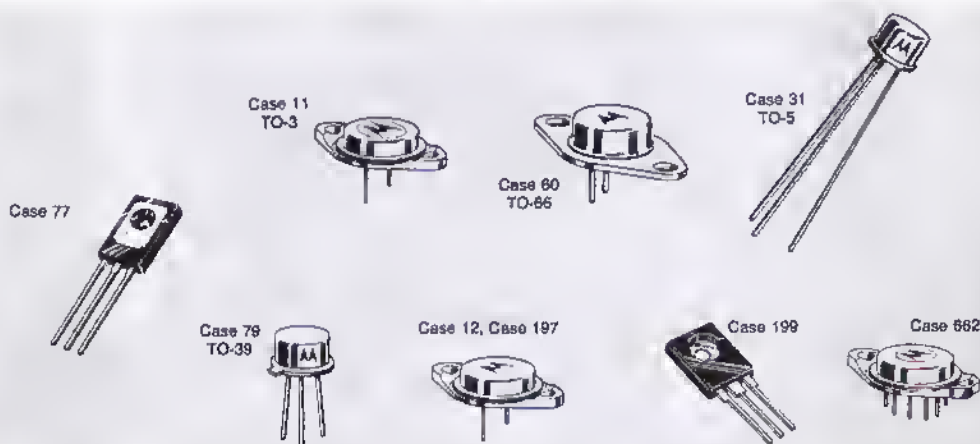
| Device and Polarity | | I_C Amp Max | V_{CE0} Volts Max | h_{FE} Min/Max | @ I_C Amp | $V_{CE(sat)}$ Volts Max | @ I_C Amp | P_D Watts Max | Case |
|---------------------|---------|---------------------|---------------------------|---------------------|-------------------|-------------------------------|-------------------|-----------------------|------|
| NPN | PNP | | | | | | | | |
| 100 MHz | | | | | | | | | |
| 2N5304 | | 10 | 40 | 30/120 | 2.0 | 0.4 | 2.0 | 25 | 9 |
| 60 MHz | | | | | | | | | |
| | 2N3867 | 3.0 | 40 | 40/200 | 1.5 | 0.75 | 1.5 | 6.0 | 31 |
| | 2N3868 | 3.0 | 60 | 30/150 | 1.5 | 0.75 | 1.5 | 6.0 | 31 |
| 50 MHz | | | | | | | | | |
| 2N6408 | 2N6408 | 2.0 | 60 | 50/250 | 0.1 | 1.4 | 1.5 | 12.5 | 77 |
| 2N6409 | 2N6407 | 2.0 | 80 | 50/250 | 0.1 | 1.4 | 1.5 | 12.5 | 77 |
| 2N6410 | 2N6411 | 4.0 | 25 | 45/180 | 2.0 | 0.8 | 2.0 | 15 | 77 |
| 2N6412 | 2N6414 | 4.0 | 40 | 40/250 | 0.2 | 0.8 | 1.0 | 15 | 77 |
| 2N6413 | 2N6415 | 4.0 | 50 | 40/250 | 0.2 | 0.8 | 1.0 | 15 | 77 |
| 40 MHz | | | | | | | | | |
| 2N6416 | 2N6418 | 3.0 | 80 | 40/250 | 0.2 | 1.0 | 1.0 | 15 | 77 |
| 2N6417 | 2N6419 | 3.0 | 100 | 40/250 | 0.2 | 1.0 | 1.0 | 15 | 77 |
| | 2N6436 | 25 | 80 | 20/80 | 10 | 1.0 | 10 | 200 | 11 |
| | 2N6437 | 25 | 100 | 20/80 | 10 | 1.0 | 10 | 200 | 11 |
| 2N6338 | | 25 | 100 | 30/120 | 10 | 1.0 | 10 | 200 | 11 |
| | 2N6438 | 25 | 120 | 20/80 | 10 | 1.0 | 10 | 200 | 11 |
| 2N6339 | | 25 | 120 | 30/120 | 10 | 1.0 | 10 | 200 | 11 |
| 2N6340 | | 25 | 140 | 30/120 | 10 | 1.0 | 10 | 200 | 11 |
| 2N6341 | | 25 | 150 | 30/120 | 10 | 1.0 | 10 | 200 | 11 |
| 30 MHz | | | | | | | | | |
| MJ7161 | | 8.0 | 400 | 25/100 | 3.0 | 1.0 | 3.0 | 140 | 11 |
| MJ7160 | | 8.0 | 300 | 25/100 | 3.0 | 1.0 | 3.0 | 140 | 11 |
| MJ7260 | | 15 | 300 | 25/100 | 5.0 | 1.0 | 5.0 | 175 | 11 |
| MJ7261 | | 15 | 400 | 25/100 | 5.0 | 1.0 | 5.0 | 175 | 11 |
| | 2N6377 | 50 | 80 | 30/120 | 20 | 1.2 | 20 | 250 | 197 |
| 2N6274 | 2N6378 | 50 | 100 | 30/120 | 20 | 1.2 | 30 | 250 | 197 |
| 2N6275 | 2N6379 | 50 | 120 | 30/120 | 20 | 1.2 | 30 | 250 | 197 |
| 2N6276 | | 50 | 140 | 30/120 | 20 | 3.0 | 50 | 250 | 197 |
| 2N6277 | | 50 | 150 | 30/120 | 20 | 3.0 | 50 | 250 | 197 |
| 25 MHz | | | | | | | | | |
| 2N6037 | 2N6034 | 4.0 | 40 | 750/16k | 2.0 | 2.0 | 2.0 | 40 | 77 |
| 2N6495 | | 10 | 80 | 10/80 | 10 | 1.5 | 10 | 70 | 80 |
| 20 MHz | | | | | | | | | |
| MJE3300 | MJE3310 | 4.0 | 40 | 1k/- | 1.0 | 1.5 | 1.5 | 15 | 77 |
| MJE3301 | MJE3311 | 4.0 | 80 | 1k/- | 1.0 | 1.5 | 1.5 | 15 | 77 |
| MJE3302 | MJE3312 | 4.0 | 80 | 1k/- | 1.0 | 1.5 | 1.5 | 15 | 77 |
| 2N8383 | | 10 | 40 | 1k/20k | 5.0 | 2.0 | 5.0 | 100 | 11 |
| 2N8384 | | 10 | 60 | 1k/20k | 5.0 | 2.0 | 5.0 | 100 | 11 |
| 2N8385 | | 10 | 80 | 1k/20k | 5.0 | 2.0 | 5.0 | 100 | 11 |

Motorola Replacements for Popular TIP Series

| Type Number | Motorola Nearest Equivalent | Polarity | I _c Amp Max | V _{ceo} Volts Max | Case |
|-------------|-----------------------------|----------|------------------------|----------------------------|------|
| TIP29 | MJE29 | NPN | 1.0 | 40 | 77R |
| TIP29A | MJE29A | NPN | 1.0 | 60 | 77R |
| TIP29B | MJE29B | NPN | 1.0 | 80 | 77R |
| TIP29C | MJE29C | NPN | 1.0 | 100 | 77R |
| TIP30 | MJE30 | PNP | 1.0 | 40 | 77R |
| TIP30A | MJE30A | PNP | 1.0 | 60 | 77R |
| TIP30B | MJE30B | PNP | 1.0 | 80 | 77R |
| TIP30C | MJE30C | PNP | 1.0 | 100 | 77R |
| TIP31 | MJE31 | NPN | 3.0 | 40 | 77R |
| TIP31A | MJE31A | NPN | 3.0 | 60 | 77R |
| TIP31B | MJE31B | NPN | 3.0 | 80 | 77R |
| TIP31C | MJE31C | NPN | 3.0 | 100 | 77R |
| TIP32 | MJE32 | PNP | 3.0 | 40 | 77R |
| TIP32A | MJE32A | PNP | 3.0 | 60 | 77R |
| TIP32B | MJE32B | PNP | 3.0 | 80 | 77R |
| TIP32C | MJE32C | PNP | 3.0 | 100 | 77R |
| TIP33 | MJE33 | NPN | 10 | 40 | 199 |
| TIP33A | MJE33A | NPN | 10 | 60 | 199 |
| TIP33B | MJE33B | NPN | 10 | 80 | 199 |
| TIP33C | MJE33C | NPN | 10 | 100 | 199 |
| TIP34 | MJE34 | PNP | 10 | 40 | 199 |
| TIP34A | MJE34A | PNP | 10 | 60 | 199 |
| TIP34B | MJE34B | PNP | 10 | 80 | 199 |
| TIP34C | MJE34C | PNP | 10 | 100 | 199 |
| TIP41 | MJE41 | NPN | 6.0 | 40 | 199 |
| TIP41A | MJE41A | NPN | 6.0 | 60 | 199 |
| TIP41B | MJE41B | NPN | 6.0 | 80 | 199 |
| TIP41C | MJE41C | NPN | 6.0 | 100 | 199 |
| TIP42 | MJE42 | PNP | 6.0 | 40 | 199 |
| TIP42A | MJE42A | PNP | 6.0 | 60 | 199 |
| TIP42B | MJE42B | PNP | 6.0 | 80 | 199 |
| TIP42C | MJE42C | PNP | 6.0 | 100 | 199 |
| TIP47 | MJE47 | NPN | 1.5 | 250 | 77 |
| TIP48 | MJE48 | NPN | 1.5 | 300 | 77 |
| TIP49 | MJE49 | NPN | 1.5 | 350 | 77 |
| TIP51 | MJE51 | NPN | 5.0 | 250 | 199 |
| TIP52 | MJE52 | NPN | 5.0 | 300 | 199 |
| TIP53 | MJE53 | NPN | 5.0 | 350 | 199 |

R Suffix Indicates reverse pin outs.

SILICON POWER DEVICE PACKAGES





SMALL-SIGNAL METAL TRANSISTORS

Silicon Small-Signal Transistors

500 AND GROWING! That phrase aptly describes the number of different classifications in Motorola's line of small-signal transistors. And with this many device type numbers covering the small-signal transistor spectrum, it is apparent that the actual differences between some devices becomes quite small. Even when the line is divided into its two natural categories — plastic for lowest cost, and metal for hermeticity — the sheer number of devices in each category makes selection by spec-for-spec comparison a significant task. This selector guide, therefore, ignores the large bulk of general-purpose, small-signal type numbers and concentrates on those transistors that have emerged as the best values in various applications categories.

Since the devices highlighted here are the most popular in each category, it follows that they are among the most widely available, at the lowest cost. They are particularly well-suited for new designs where a continuous, off-the-shelf supply of product is required.

The reader is reminded, however, that semiconductors are manufactured by "batch" processes, and that each "batch" may yield devices with widely varying parameters. This creates device "families". While the various specifications limits assigned to "family members" have been selected on the basis of demonstrated industry need, modern testing methods have made the selection of devices with special characteristics simple and inexpensive. Where the specified characteristics of the "preferred" devices listed in the following selector guides do not meet a particular design requirement, the designer is requested to contact his nearest Motorola sales representative for price quotations on special devices to fit his needs.

TABLE OF CONTENTS

| | Page |
|---|------|
| Small-Signal Metal Transistors | |
| Switching Transistors | |
| ... for use in general-purpose amplifiers and switching applications | 4-15 |
| High-Gain Low-Noise Transistors | |
| ... for low-noise, low-level amplifier applications | 4-17 |
| High-Voltage Amplifiers | |
| ... for use in general-purpose, high voltage applications | 4-17 |
| High-Frequency Amplifier/Oscillators | |
| ... high-frequency power oscillators, multipliers and driver applications | 4-18 |
| General-Purpose Amplifiers | |
| ... for use in general purpose amplifier and switching applications | 4-19 |

SMALL-SIGNAL METAL TRANSISTORS (Continued)

The following index reflects the devices characterized in this section. To locate the exact page number, see Catalog Index (Page 7-1).

INDEX

Switching Transistors

NPN

2N2206
2N2319
2N2368
2N2369
2N2369A
2N2539
2N2540
2N2845
2N3011
2N3227
2N3252S
2N3253S
2N3444S
2N3508
2N3507
2N3508
2N3509
2N3647
2N3648
2N3724
2N3725
2N3734
2N3735
2N3736
2N3737
2N4013
2N4014
2N5859
2N5861
MM3220
MM3734
MM3736
MM3737
MM5189
MM5262

PNP

2N869A
2N3012
2N3244S
2N3245S
2N3249
2N3488S
2N3546
2N3634S
2N3635S
2N3636S
2N3782S
2N3783S
2N4208
2N4209
2N4404
2N4405
2N4406
2N4407
2N4890
2N4929S
MM3726
MM4001
MM4005
MM4006
MM4007
MM4030
MM4031
MM4032
MM4033
MM4038
MM4037
MM4257
MM4258

High-Gain Low-Noise

NPN

2N929
2N930
2N930A
2N2493
2N2484
MM2484

Darlington

NPN

MM6427

PNP

2N3798
2N3799

High Voltage Amplifiers

NPN

2N657S
2N1190S
2N3114S
2N3496S
2N3499S
2N3500S
2N3501S
2N3712S
2N3742S
2N4824S
2N4826
2N4827
2N5058S
2N5059S
MM2258
MM2259
MM3000
MM3001
MM3002
MM3003
MM3005
MM3006
MM3007
MM3008
MM3009

PNP

2N3494S
2N3495S
2N3499
2N3497
2N3634S
2N3635S
2N3637S
2N3743S
2N4404
2N4405
2N4890
2N4928
2N4929S
2N4930
2N4931S
MM4000
MM4001
MM4002
MM4003
MM4009
MM4010
MM4036
MM4037
MM5005
MM5006
MM5007

High-Frequency Amplifiers/Oscillators

NPN

2N917
2N918
2N3544
MM1941

PNP

2N3307
2N3308
2N4260
2N4261

General-Purpose Amplifiers

NPN

2N656
2N697S
2N699
2N717
2N718
2N843
2N815
2N816
2N956
2N1613S
2N1613AS
2N1711S
2N1711AS
2N1890S
2N1893S
2N2102S
2N2183AS
2N2218S
2N2218AS
2N2219S
2N2219AS
2N2221
2N2221A
2N2222
2N2222A
2N2270S
2N2287S
2N2789S
2N2951S
2N2959S
2N3018S
2N3020S
2N3053S
2N3053AS
2N3110S
2N3298S
2N3300S
2N3301
2N3302
2N3946
2N3947
2N4450
2N5581
2N5582
MM3019
MM3020
MM3053
MM3903
MM3904

PNP

2N1131S
2N1131AS
2N1132
2N1132A

2N1991S
2N2800S
2N2904S
2N2904AB
2N2905S
2N2905AS
2N2906
2N2908A
2N2907
2N2907A
2N3073
2N3133S
2N3135
2N3250
2N3250A
2N3251
2N3251A
2N3485
2N3485A
2N3486
2N3486A
2N3873
MM3905
MM3906
MM4006

Switching Transistors

The transistors listed below detail Motorola's Silicon Transistors. Prime devices are shown in Bold Face Type. Devices are listed in order of decreasing turn-on time (t_{on}).

| Package | Family | Device Type | $I_{C_{max}}$ mA | $I_{B_{max}}$ mA | $I_{C_{min}}$ mA | $V_{CE_{sat}}$ Volts | $I_{C_{max}}$ mA | $I_{B_{min}}$ mA | $I_{C_{max}}$ mA | $V_{CE_{sat}}$ Volts | $V_{CE_{sat}}$ mA | $I_{C_{max}}$ mA | f_t MHz | t_{on} ns |
|---------|--------|-------------|---------------------|---------------------|---------------------|-------------------------|---------------------|---------------------|---------------------|-------------------------|----------------------|---------------------|--------------|----------------|
| NPN | | | | | | | | | | | | | | |
| TO-18 | 5 | 2N2845 | 40 | 40 | 150 | 30 | — | 30 | 150 | 0.4 | 150 | 15 | 250 | 50 |
| | | 2N2540 | 40 | 40 | 150 | 30 | — | 100 | 150 | 0.45 | 150 | 15 | 250 | 20 |
| | | 2N2539 | 40 | 40 | 150 | 30 | — | 50 | 150 | 0.45 | 150 | 15 | 250 | 20 |
| TO-5 | 22 | 2N3507S | 45 | 60 | 1500 | 50 | 3000 | 30 | 1500 | 1.0 | 1500 | 150 | 60 | 100 |
| | | 2N3506S | 45 | 60 | 1500 | 40 | 3000 | 40 | 1500 | 1.0 | 1500 | 150 | 60 | 100 |
| TO-52 | 27 | 2N3444S | 50 | 70 | 500 | 50 | — | 20 | 500 | 0.6 | 500 | 50 | 175 | 50 |
| | | 2N3253S | 50 | 70 | 500 | 40 | — | 25 | 500 | 0.6 | 500 | 50 | 175 | 50 |
| TO-39 | 27 | 2N3252S | 45 | 70 | 500 | 30 | — | 30 | 500 | 0.5 | 500 | 50 | 200 | 50 |
| | | 2N3725 | 35 | 60 | 500 | 60 | 2000 | 35 | 500 | 0.52 | 500 | 50 | 300 | 50 |
| | | 2N3724 | 35 | 60 | 500 | 30 | 2000 | 35 | 500 | 0.42 | 500 | 60 | 500 | 50 |
| | | 2N3735 | 48 | 60 | 1000 | 75 | 1500 | 20 | 1000 | 0.5 | 500 | 50 | 250 | 50 |
| | | 2N3734 | 48 | 60 | 1000 | 50 | 1500 | 30 | 1000 | 0.5 | 500 | 50 | 250 | 50 |
| | | MM5189 | 40 | 70 | — | 40 | 2000 | 20 | 1000 | 1.0 | 1000 | 100 | 350 (typ) | 50 |
| | | 2N5859 | 35 | 60 | 1000 | 40 | 2000 | 15 | 1000 | 0.4 | 500 | 50 | 250 | 50 |
| | | MM3734 | 35 | 60 | 1000 | 30 | 1500 | 25 | 1000 | 0.5 | 500 | 50 | 200 | 50 |
| | | MM5262 | 30 | 60 | 1000 | 50 | 2000 | 25 | 1000 | 0.8 | 1000 | 100 | 350 (typ) | 50 |
| | | 2N5861 | 25 | 60 | 500 | 50 | 2000 | 25 | 500 | 0.5 | 500 | 50 | 200 | 50 |
| TO-18 | 73 | 2N4014 | 35 | 60 | 500 | 50 | 1000 | 35 | 500 | 0.52 | 500 | 50 | 300 | 50 |
| | | 2N4013 | 35 | 60 | 500 | 30 | 1000 | 35 | 500 | 0.42 | 500 | 50 | 500 | 50 |
| TO-46 | 73 | 2N3011 | 15 | 20 | 30 | 12 | 200 | 25 | 30 | 0.25 | 30 | 3.0 | 400 | 20 |
| | | 2N3227 | 12 | 18 | 100 | 20 | 500 | 30 | 100 | 0.25 | 10 | 1.0 | 500 | 10 |
| | | 2N2389 | 12 | 18 | 100 | 15 | 500 | 20 | 100 | 0.25 | 10 | 1.0 | 500 | 10 |
| | | 2N2389A | 12 | 18 | 10 | 15 | 200 | 40 | 10 | 0.2 | 10 | 1.0 | 500 | 10 |
| | | 2N2388 | 12 | 15 | 10 | 15 | — | 20 | 10 | 0.25 | 10 | 1.0 | 400 | 10 |
| | | 2N2319 | 60 | 50 | 20 | 15 | 200 | 40 | 20 | 0.35 | 20 | 1.0 | 300 | 10 |
| | | 2N2206 | 40 | 75 | 10 | 12 | 200 | 40 | 10 | 220 | 10 | 1.0 | 200 | 10 |
| | | 2N3508 | 12 | 18 | 10 | 20 | 500 | 40 | 10 | 0.25 | 10 | 1.0 | 500 | 10 |
| | | 2N3509 | 12 | 18 | 10 | 20 | 500 | 100 | 10 | 0.25 | 10 | 1.0 | 500 | 10 |
| | | 2N3509 | 12 | 18 | 10 | 20 | 500 | 100 | 10 | 0.25 | 10 | 1.0 | 500 | 10 |
| TO-46 | 81 | 2N3647 | 20 | 25 | 150 | 10 | 500 | 25 | 150 | 0.4 | 150 | 15 | 350 | 15 |
| | | 2N3648 | 16 | 18 | 150 | 15 | 500 | 30 | 150 | 0.4 | 150 | 15 | 450 | 15 |
| TO-48 | 99 | 2N3737 | 48 | 60 | 1000 | 50 | 1500 | 20 | 1000 | 0.5 | 500 | 50 | 250 | 50 |
| | | 2N3736 | 48 | 60 | 1000 | 30 | 1500 | 30 | 1000 | 0.5 | 500 | 60 | 250 | 50 |
| | | MM3737 | 45 | 65 | 1000 | 50 | 1500 | 20 | 1000 | 0.5 | 500 | 50 | 200 | 50 |
| | | MM3736 | 45 | 65 | 1000 | 30 | 1500 | 30 | 1000 | 0.5 | 500 | 50 | 200 | 50 |

SMALL-SIGNAL METAL TRANSISTORS (Continued)

Switching Transistors (Continued)

| Package | Family | Device Type | t_{on} ns Max | t_{off} ns Max | β @ I_C mA | BV_{CEO} Volts Min | I_C mA Max | h_{FE} Min | β @ I_C mA | Volts Max | $V_{CE(sat)}$ @ I_C mA | I_B mA | f_T MHz Min | β @ I_C mA |
|---------|--------|-------------|-----------------------|------------------------|-----------------------------|----------------------------|--------------------|-----------------|-----------------------------|--------------|-----------------------------------|-------------|---------------------|-----------------------------|
| PNP | | | | | | | | | | | | | | |
| TO-18 | 44 | 2N3249 | 80 | 100 | 10 | 12 | — | 100 | 10 | 0.125 | 10 | 1.0 | 300 | 20 |
| | | 2N889A | 50 | 80 | 30 | 18 | 200 | 40 | 30 | 0.2 | 30 | 3.0 | 400 | 10 |
| | | 2N2894 | 60 | 80 | 30 | 12 | 200 | 40 | 30 | 0.2 | 30 | 3.0 | 400 | 30 |
| | | 2N3012 | 60 | 75 | 30 | 12 | 200 | 30 | 30 | 0.2 | 30 | 3.0 | 400 | 30 |
| TO-18 | 45 | 2N3546 | 40 | 30 | 50 | 12 | — | 25 | 50 | 0.25 | 50 | 5.0 | 700 | 10 |
| TO-39 | 50 | 2N4890S | 100 | 270 | 150 | 40 | 500 | 50 | 150 | 1.4 | 150 | 15 | 100 | 50 |
| | | MM4036 | 75 | 175 | 150 | 65 | 1000 | 40 | 150 | 0.65 | 150 | 15 | 60 | 50 |
| | | MM4037 | 75 | 175 | 150 | 40 | 1000 | 50 | 150 | 1.4 | 150 | 15 | 80 | 50 |
| | | 2N4405 | 40 | 210 | 500 | 80 | 1000 | 25 | 500 | 0.5 | 500 | 50 | 200 | 50 |
| | | 2N4404 | 40 | 210 | 500 | 80 | 1000 | 15 | 500 | 0.5 | 500 | 50 | 200 | 50 |
| TO-39 | 56 | MM4031 | 100 | 240 (typ) | 500 | 80 | 1000 | 25 | 500 | 0.5 | 500 | 50 | 100 | 50 |
| | | MM4033 | 100 | 240 (typ) | 500 | 80 | 1000 | 70 | 500 | 0.5 | 500 | 50 | 150 | 50 |
| | | MM4032 | 100 | 240 (typ) | 500 | 50 | 1000 | 70 | 500 | 0.5 | 500 | 50 | 150 | 50 |
| | | MM4030 | 100 | 240 (typ) | 500 | 80 | 1000 | 25 | 500 | 0.5 | 500 | 50 | 100 | 50 |
| | | 2N4407 | 75 | 225 | 1000 | 80 | 2000 | 15 | 1000 | 0.7 | 1000 | 100 | 150 | 50 |
| | | 2N4406 | 75 | 225 | 1000 | 80 | 2000 | 10 | 1000 | 0.7 | 1000 | 100 | 150 | 50 |
| | | MM4007 | — | — | — | 100 | 1000 | 50 | 150 | 0.1 (typ) | 150 | 15 | 50 | 50 |
| | | MM4006 | — | — | — | 80 | 1000 | 50 | 150 | 0.1 (typ) | 150 | 15 | 50 | 50 |
| | | MM4005 | — | — | — | 80 | 1000 | 50 | 150 | 0.1 (typ) | 150 | 15 | 50 | 50 |
| TO-39 | 50 | 2N3783S | 43 | 115 | 1000 | 50 | 1500 | 20 | 1000 | 0.9 | 1000 | 100 | 150 | 50 |
| | | 2N3782S | 43 | 115 | 1000 | 40 | 1500 | 30 | 1000 | 0.9 | 1000 | 100 | 180 | 50 |
| TO-38 | 337 | 2N3245S | 55 | 165 | 500 | 50 | 1000 | 30 | 500 | 0.8 | 500 | 50 | 150 | 50 |
| | | 2N3244S | 50 | 185 | 500 | 40 | 1000 | 50 | 500 | 0.5 | 500 | 50 | 175 | 50 |
| | | 2N3468S | 40 | 80 | 500 | 50 | 1000 | 25 | 500 | 0.6 | 500 | 50 | 150 | 50 |
| | | 2N3467S | 40 | 80 | 500 | 40 | 100 | 40 | 500 | 0.5 | 500 | 50 | 175 | 50 |
| | | MM3726 | 35 | 60 | 1000 | 50 | 1500 | 15 | 1000 | 1.2 | 1000 | 100 | 200 | 50 |
| TO-18 | 345 | 2N4209 | 15 | 20 | 10 | 15 | 200 | 50 | 10 | 0.18 | 10 | 1.0 | 850 | 10 |
| | | 2N4208 | 15 | 20 | 10 | 12 | 200 | 30 | 10 | 0.15 | 10 | 1.0 | 700 | 10 |
| | | MM4258 | 15 | 20 | 10 | 12 | 80 | 30 | 10 | 0.15 | 10 | 1.0 | 700 | 10 |
| | | MM4257 | 15 | 15 | 10 | 6.0 | 80 | 30 | 10 | 0.15 | 10 | 1.0 | 500 | 10 |
| TO-39 | 454 | 2N3636S | 400 | 600 | 50 | 175 | 1000 | 50 | 50 | 0.5 | 50 | 5.0 | 150 | 30 |
| | | 2N3635S | 400 | 600 | 50 | 140 | 1000 | 100 | 50 | 0.5 | 50 | 5.0 | 200 | 30 |
| | | 2N3634S | 400 | 600 | 50 | 140 | 1000 | 50 | 50 | 0.5 | 50 | 5.0 | 150 | 30 |
| | | 2N4929S | — | — | — | 150 | 500 | 25 | 10 | 0.5 | 10 | 1.0 | 100 | 20 |
| | | MM4001 | — | — | — | 150 | 500 | 20 | 10 | 0.6 | 10 | 1.0 | — | — |

High-Gain Low-Noise Transistors

The transistors are characterized for high-gain and low-noise applications. Devices are listed in decreasing order of NF.

| Package | Family | Device Type | NF Wideband Typ* Max dB | BV_{CEO} Volts Min | I_C mA Max | Min | h_{FE} | Max | f_T MHz @ I_C mA* | 17 MHz Min | @ I_C mA |
|----------------|--------|-------------|----------------------------------|----------------------------|--------------------|------|----------|-----|--------------------------------|------------------|---------------|
| NPN | | | | | | | | | | | |
| TO-18 | 18 | 2N2483 | 8.0* | 60 | 50 | 40 | 120 | 10 | 12 | 0.05 | |
| | | 2N2484 | 8.0* | 60 | 50 | 100 | 500 | 10 | 15 | 0.05 | |
| | | 2N929 | 4.0 | 45 | 30 | 40 | 120 | 10 | 30 | 0.5 | |
| | | 2N930A | 3.0 | 45 | 30 | 100 | 300 | 10 | 45 | 0.5 | |
| | | 2N930 | 3.0 | 45 | 30 | 100 | 300 | 10 | 30 | 0.5 | |
| NPN DARLINGTON | | | | | | | | | | | |
| TO-18 | 914 | MM9427 | — | 40 | 300 | 5000 | — | 10* | 125 | 100 | |
| PNP | | | | | | | | | | | |
| TO-18 | 55 | 2N3798 | 3.5 | 60 | 50 | 150 | 450 | 500 | 30 | 0.5 | |
| | | 2N3799 | 2.5 | 60 | 50 | 300 | 900 | 500 | 30 | 0.5 | |

High-Voltage Amplifiers

The following table lists Motorola standard devices that have high Collector-Emitter Breakdown Voltage. Prime devices are shown in Bold Face Type. Devices are listed in decreasing order of BV_{CEO} .

| Package | Family | Device Type | BV_{CEO} Volts Min | I_C mA Max | h_{FE} Min | h_{FE} @ I_C mA | $V_{CE(sat)}$ Volts Max | I_C mA | I_C mA | f_T MHz Min | f_T MHz @ I_C mA |
|------------|--------|-------------|----------------------------|--------------------|-----------------|---------------------------|-------------------------------|-------------|-------------|---------------------|-------------------------------|
| NPN | | | | | | | | | | | |
| TO-39 | 8 | MM3009 | 180 | 400 | 40 | 10 | — | — | — | 50 | 20 |
| | | MM3008 | 120 | 400 | 40 | 10 | — | — | — | 50 | 20 |
| TO-39 | 26R | MM2259 | 175 | 300 | 35 | 10 | 0.4 | 25 | 2.5 | 150 | 20 |
| | | 2N3501S | 150 | 300 | 100 | 150 | 0.4 | 150 | 15 | 150 | 20 |
| | | 2N3500S | 150 | 300 | 40 | 150 | 0.4 | 150 | 15 | 150 | 20 |
| | | 2N3114S | 150 | 200 | 30 | 30 | 1.0 | 50 | 5.0 | 40 | 30 |
| | | 2N3712S | 150 | 200 | 30 | 30 | 2.0 | 50 | 5.0 | 40 | 30 |
| | | MM3001 | 150 | 200 | 20 | 10 | — | — | — | 150 | 10 |
| | | MM2258 | 120 | 500 | 50 | 10 | 0.4 | 25 | 2.5 | 150 | 20 |
| | | 2N3499S | 100 | 500 | 100 | 150 | 0.6 | 300 | 30 | 150 | 20 |
| | | 2N3498S | 100 | 500 | 40 | 150 | 0.6 | 300 | 30 | 150 | 20 |
| | | 2N4924S | 100 | 200 | 40 | 150 | 0.4 | 50 | 5.0 | 100 | 20 |
| | | 2N657S | 100 | — | 30 | 200 | 4.0 | 200 | 40 | — | — |
| | | 2N1990S | — | 1000 | 20 | 30 | 0.5 | 2.0 | 0.2 | — | — |
| TO-39 | 88 | MM3007 | 100 | 2500 | 50 | 250 | 0.35 | 150 | 15 | 50 | 50 |
| | | MM3006 | 80 | 2500 | 50 | 200 | 0.35 | 150 | 15 | 50 | 50 |
| | | MM3005 | 60 | 2500 | 50 | 150 | 0.35 | 150 | 15 | 50 | 50 |
| TO-39 | 210R | 2N5058S | 300 | 150 | 35 | 30 | 1.0 | 30 | 3.0 | 30 | 10 |
| | | 2N3742S | 300 | 50 | 20 | 30 | 1.0 | 30 | 3.0 | 30 | 10 |
| | | 2N5059S | 250 | 150 | 30 | 30 | 1.0 | 30 | 3.0 | 30 | 10 |
| | | 2N4927 | 250 | 50 | 20 | 30 | 2.0 | 30 | 3.0 | 30 | 10 |
| | | MM3003 | 250 | 50 | 20 | 10 | — | — | — | 150 | 10 |
| | | 2N4926 | 200 | 50 | 20 | 30 | 2.0 | 30 | 3.0 | 30 | 10 |
| | | MM3002 | 200 | 50 | 20 | 10 | — | — | — | 150 | 10 |

SMALL-SIGNAL METAL TRANSISTORS (Continued)

High-Voltage Amplifiers (Continued)

| Package | Family | Device Type | BV_{CEO} Volts Min | I_C mA Max | h_{FE} Min | I_C mA | $V_{CE(sat)}$ Volts Max | I_C mA | I_C mA | f_T MHz Min | I_C mA |
|---------|--------|-------------|----------------------------|--------------------|-----------------|-------------|-------------------------------|-------------|-------------|---------------------|-------------|
| PNP | | | | | | | | | | | |
| TO-39 | 46 | 2N3495S | 120 | 100 | 40 | 10 | 0.35 | 10 | 1.0 | 150 | 20 |
| | | 2N4928S | 100 | 100 | 25 | 10 | 0.5 | 10 | 1.0 | 100 | 20 |
| | | MM4000 | 100 | 100 | 20 | 10 | 0.6 | 10 | 1.0 | — | — |
| | | 2N3494S | 80 | 100 | 40 | 10 | 0.3 | 10 | 1.0 | 200 | 20 |
| TO-18 | 47 | 2N3497 | 120 | 100 | 40 | 10 | 0.35 | 10 | 1.0 | 150 | 20 |
| | | 2N3496 | 80 | 100 | 40 | 10 | 0.3 | 10 | 1.0 | 200 | 20 |
| TO-39 | 49 | MM4010 | 100 | 500 | 75 | 10 | 0.2 (typ) | 10 | 1.0 | 150 (typ) | 20 |
| | | MM5007 | 100 | 2000 | 50 | 250 | 0.5 | 150 | 15 | 30 | 50 |
| | | MM4009 | 80 | 500 | 75 | 10 | 0.2 (typ) | 10 | 1.0 | 150 (typ) | 20 |
| | | MM5008 | 80 | 2000 | 50 | 200 | 0.5 | 150 | 15 | 30 | 50 |
| | | MM5005 | 60 | 2000 | 50 | 150 | 0.5 | 150 | 15 | 30 | 50 |
| TO-39 | 50 | 2N4405 | 80 | 1000 | 100 | 150 | 0.2 | 150 | 15 | 200 | 50 |
| | | 2N4404 | 80 | 1000 | 40 | 150 | 0.2 | 150 | 15 | 200 | 50 |
| | | MM4036 | 65 | 1000 | 20 | 150 | 0.65 | 150 | 15 | 60 | 50 |
| | | MM4037 | 40 | 1000 | 50 | 150 | 1.4 | 150 | 15 | 50 | 50 |
| | | 2N4890S | 40 | 500 | 50 | 150 | 1.4 | 150 | 15 | 100 | 50 |
| TO-39 | 452R | 2N3743S | 300 | 50 | 25 | 30 | 6.0 | 30 | 3.0 | 30 | 10 |
| | | 2N4931S | 250 | 500 | 20 | 20 | 5.0 | 10 | 1.0 | 20 | 20 |
| | | MM4003 | 250 | 300 | 20 | 10 | 5.0 | 10 | 1.0 | — | — |
| | | 2N4930S | 200 | 500 | 20 | 20 | 5.0 | 10 | 1.0 | 20 | 20 |
| | | MM4002 | 200 | 500 | 20 | 10 | 5.0 | 10 | 1.0 | — | — |
| TO-39 | 454R | 2N3637S | 175 | 1000 | 100 | 50 | 0.5 | 50 | 5.0 | 200 | 30 |
| | | 2N3636S | 175 | 1000 | 50 | 50 | 0.5 | 50 | 5.0 | 150 | 30 |
| | | 2N4929S | 150 | 600 | 25 | 10 | 0.5 | 10 | 1.0 | 100 | 20 |
| | | MM4001 | 150 | 500 | 20 | 10 | 0.6 | 10 | 1.0 | — | — |
| | | 2N3635S | 140 | 1000 | 100 | 50 | 0.5 | 50 | 5.0 | 200 | 30 |
| | | 2N3634S | 140 | 1000 | 50 | 50 | 0.5 | 50 | 5.0 | 150 | 30 |

High-Frequency Amplifiers/ Oscillators

The transistors shown are designed for use as both oscillators and amplifiers at UHF and VHF frequencies. Devices are listed in decreasing order of BV_{CEO} .

| Package | Family | Device Type | BV_{CEO} Volts Min | h_{FE} Min | β | I_C mA | G_{os} dB Min | NF dB Max | f MHz | f_T MHz Min | β | I_C mA | C_{ob} pF Max |
|---------|--------|-------------|----------------------------|-----------------|---------|-------------|-----------------------|-----------------|------------|---------------------|---------|-------------|-----------------------|
| NPN | | | | | | | | | | | | | |
| TO-72 | 72 | 2N917 | 15 | 20 | 3.0 | 9.0 | 6.0 | 50 | 500 | 4.0 | 1.7 | | |
| | | 2N918 | 15 | 20 | 3.0 | 15 | 6.0 | 50 | 600 | 4.0 | 1.7 | | |
| TO-38 | 75 | 2N3544 | 25 | 25 | 10 | — | — | — | 600 | 10 | 2.5 | | |
| | | MM1941 | 20 | 25 | 10 | 7.0 | — | — | 600 | 10 | 2.5 | | |
| PNP | | | | | | | | | | | | | |
| TO-18 | 63 | 2N3307 | 35 | 40 | 2.0 | 17 | 4.5 | 200 | 900 | 2.0 | 1.3 | | |
| | | 2N3306 | 25 | 25 | 2.0 | 17 | 6.0 | 200 | 300 | 2.0 | 1.6 | | |
| TO-72 | 65 | 2N4281 | 15 | 30 | 10 | — | — | — | 1600 | 10 | 2.5 | | |
| | | 2N4260 | 15 | 30 | 10 | — | — | — | 2000 | 10 | 2.5 | | |

General-Purpose Amplifiers

These transistors are designed for high speed switching circuits, dc to VHF amplifier applications and complementary circuitry. Prime devices are shown in Bold Face Type. Devices are listed in decreasing order of BV_{CEO} .

| Package | Family | Device Type | BV_{CEO} V ₀ R _s Min | f_t MHz Min | @ | I_C mA Max | I_C mA Max | h_{FE} Min | h_{FE} Max | @ | I_C mA Max |
|---------|--------|-----------------|--|---------------------|----|--------------------|--------------------|-----------------|-----------------|---|--------------------|
| NPN | | | | | | | | | | | |
| TO-39 | 2R | 2N2959S | 60 | 250 | 20 | 600 | 100 | 300 | 150 | | |
| | | 2N2951S | 80 | 200 | 10 | 250 | 20 | 150 | 10 | | |
| | | 2N1711S | 80 | 70 | 50 | — | 100 | 300 | 150 | | |
| | | 2N1813S | 50 | 60 | 50 | 500 | 40 | 120 | 150 | | |
| | | 2N2219AS | 40 | 300 | 20 | 800 | 100 | 300 | 150 | | |
| | | 2N2218AS | 40 | 250 | 20 | 800 | 40 | 120 | 150 | | |
| | | 2N697S | 40 | 50 | 50 | — | 40 | 120 | 150 | | |
| | | 2N2789S | 35 | 250 | 20 | 800 | 100 | 300 | 150 | | |
| | | 2N3299S | 30 | 250 | 50 | 500 | 40 | 120 | 150 | | |
| | | 2N3300S | 30 | 250 | 50 | 500 | 100 | 300 | 150 | | |
| | | 2N2218S | 30 | 250 | 20 | 800 | 40 | 120 | 150 | | |
| | | 2N2219S | 30 | 250 | 20 | 800 | 100 | 300 | 150 | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| TO-46 | 2S | 2N5582 | 40 | 300 | 20 | 800 | 100 | 300 | 150 | | |
| | | 2N5581 | 40 | 250 | 20 | 600 | 40 | 120 | 150 | | |
| | | 2N4450 | 30 | 250 | 50 | 500 | 100 | 300 | 150 | | |
| TO-18 | 3 | 2N956 | 50 | 70 | 50 | — | 40 | 120 | 150 | | |
| | | 2N843 | 45 | 40 | 10 | 800 | 45 | 150 | 10 | | |
| | | 2N2222A | 40 | 300 | 20 | 800 | 100 | 300 | 150 | | |
| | | 2N2221A | 40 | 250 | 20 | 800 | 40 | 120 | 150 | | |
| | | 2N718 | 40 | 50 | 50 | — | 40 | 120 | 150 | | |
| | | 2N717 | 40 | 40 | 50 | 500 | 20 | 60 | 150 | | |
| | | 2N3001 | 30 | 250 | 50 | 500 | 40 | 120 | 150 | | |
| | | 2N3302 | 30 | 250 | 50 | 500 | 100 | 300 | 150 | | |
| | | 2N2221 | 30 | 250 | 20 | 800 | 40 | 120 | 150 | | |
| | | 2N2222 | 30 | 250 | 20 | 800 | 100 | 300 | 150 | | |
| | | | | | | | | | | | |
| TO-39 | 14R | 2N3018S | 80 | 100 | 50 | 1000 | 100 | 300 | 150 | | |
| | | 2N3020S | 60 | 80 | 50 | 1000 | 40 | 120 | 150 | | |
| | | 2N699 | 80 | 50 | 50 | — | 40 | 120 | 150 | | |
| | | 2N1893S | 80 | 50 | 50 | 500 | 40 | 120 | 150 | | |
| | | 2N2102S | 65 | 80 | 50 | 1000 | 40 | 120 | 150 | | |
| | | 2N3053AS | 60 | 100 | 50 | 700 | 50 | 250 | 150 | | |
| | | 2N1890S | 60 | 60 | 50 | 500 | 100 | 300 | 150 | | |
| | | 2N656S | 80 | — | — | — | 30 | 80 | 200 | | |
| | | MM3053 | 50 | 100 | 50 | 1000 | 40 | 300 | 150 | | |
| | | 2N2193AS | 50 | 50 | 50 | 1000 | 40 | 120 | 150 | | |
| | | 2N2270S | 45 | 100 | 50 | 1000 | 50 | 200 | 150 | | |
| | | 2N3110S | 40 | 600 | 10 | 1000 | 40 | 120 | 150 | | |
| | | 2N3053S | 40 | 100 | 50 | 700 | 50 | 250 | 150 | | |
| | | 2N2297S | 35 | 80 | 50 | 1000 | 40 | 120 | 150 | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| TO-18 | 23 | 2N915 | 50 | 250 | 10 | — | 50 | 200 | 10 | | |
| | | 2N3946 | 40 | 300 | 10 | 200 | 50 | 150 | 10 | | |
| | | 2N3947 | 40 | 300 | 10 | 200 | 100 | 300 | 10 | | |
| | | 2N916 | 25 | 300 | 10 | — | 50 | 200 | 10 | | |
| TO-52 | 221 | MM3904 | 40 | 300 | 10 | 200 | 100 | 300 | 10 | | |
| | | MM3903 | 40 | 250 | 10 | 200 | 50 | 150 | 10 | | |

SMALL-SIGNAL METAL TRANSISTORS (Continued)

General - Purpose Amplifiers (Continued)

| Package | Family | Device Type | V_{CE0} Volts Min | f_r MHz Min | @ I_C mA | I_C mA Max | Min | h_{FE} Max | @ I_C mA |
|--------------------|--------|-------------|---------------------------|---------------------|------------------|--------------------|-----|-----------------|------------------|
| PNP | | | | | | | | | |
| TO-18 | 35 | 2N3251A | 60 | 300 | 10 | 200 | 100 | 300 | 10 |
| | | 2N3250A | 60 | 250 | 10 | 200 | 50 | 150 | 10 |
| | | 2N3251 | 40 | 300 | 10 | 200 | 100 | 300 | 10 |
| | | 2N3250 | 40 | 250 | 10 | 200 | 50 | 150 | 10 |
| TO-46 | 48 | 2N3485A | 60 | 200 | 50 | 600 | 40 | 120 | 150 |
| | | 2N3486A | 60 | 200 | 50 | 600 | 100 | 300 | 150 |
| | | 2N3673 | 50 | 200 | 50 | 600 | 75 | 225 | 150 |
| | | 2N3486 | 40 | 200 | 50 | 600 | 100 | 300 | 150 |
| TO-18 TO-39 | 333 | 2N2906A | 90 | 200 | 50 | 600 | 40 | 120 | 150 |
| | | 2N2907A | 60 | 200 | 50 | 600 | 100 | 300 | 150 |
| | | 2N3073 | 60 | 130 | 50 | 600 | 30 | 130 | 50 |
| | | 2N3135 | 50 | 200 | 50 | 600 | 40 | 120 | 150 |
| | | 2N2906 | 40 | 200 | 50 | 600 | 40 | 120 | 150 |
| | | 2N2907 | 40 | 200 | 50 | 600 | 100 | 300 | 150 |
| | | 2N2904AS | 60 | 200 | 50 | 600 | 40 | 120 | 150 |
| | | 2N2905AS | 60 | 200 | 50 | 600 | 100 | 300 | 150 |
| | | MM4008 | 60 | 325 (typ) | 20 | 600 | 75 | — | 10 |
| | | 2N3133S | 50 | 200 | 50 | 600 | 40 | 120 | 150 |
| | | 2N2904S | 40 | 200 | 50 | 600 | 40 | 120 | 150 |
| | | 2N2905S | 40 | 200 | 50 | 600 | 100 | 300 | 150 |
| | | 2N1132AS | 40 | 60 | 50 | 600 | 30 | 90 | 150 |
| | | 2N1131AS | 40 | 50 | 50 | 600 | 30 | 90 | 150 |
| | | 2N2806S | 35 | 120 | 50 | 600 | 30 | 90 | 150 |
| | | 2N1132S | 35 | 60 | 50 | 600 | 30 | 90 | 150 |
| | | 2N1131S | 35 | 50 | 50 | 600 | 30 | 90 | 150 |
| | | 2N1991S | 20 | 40 | 50 | 600 | 15 | 60 | 150 |
| TO-52 | 271 | MM3906 | 40 | 250 | 10 | 200 | 100 | 300 | 10 |
| | | MM3905 | 40 | 200 | 10 | 200 | 50 | 150 | 10 |

Case 31-03
TO-5



Case 22-03
TO-18



Case 79-02
TO-39



Case 26
TO-46



Case 27-02
TO-52



Case 20-3
TO-72





SMALL-SIGNAL PLASTIC-ENCAPSULATED TRANSISTORS

Plastic-Encapsulated Small-Signal Transistors for Industrial and Consumer applications

The Small-Signal Plastic Transistors represent Motorola's broadest product line. From RF/VHF/UHF amplifiers, mixers, oscillators and switches to general-purpose amplifiers and switches, all are available as standard product or custom specials. Specialty devices for the industrial, computer or consumer market as well as specialty packages — Duowatt and Uniwatt — are all available for unique high technology applications. The following list demonstrates the many applications possible with plastic transistors. If specific applications are not listed, consult your factory representative for assistance.

TABLE OF CONTENTS

| | Page |
|--|------|
| General-Purpose Amplifiers and Switches | |
| ...a quick reference guide of the most popular NPN and PNP general purpose devices | 4-24 |
| RF/UHF/VHF Amplifiers and CATV Transistors | |
| ...for high frequency applications | 4-25 |
| High-Speed Saturated Switching Transistors | |
| ...for high-speed saturated switching applications | 4-25 |
| General-Purpose Transistors | |
| ...for general purpose amplifiers and switches | 4-26 |
| Low-Noise Amplifier Transistors | |
| ...for low-noise audio amplifiers | 4-27 |
| High-Voltage Transistors | |
| ...for high-voltage amplifier and driver applications | 4-27 |
| Medium-Power (Uniwatt and Duowatt) Transistors | |
| ...for high voltage and high current amplifiers and switches | 4-28 |

The following index reflects the devices characterized in this section. To locate the exact page number, see Catalog Index (Page 7-1).

INDEX

| | | |
|---------|---------|----------|
| 2N3903 | MPS2222 | MPS-D01 |
| 2N3904 | MPS2369 | MPS-D02 |
| 2N3905 | MPS2907 | MPS-D03 |
| 2N3906 | MPS3639 | MPS-D05 |
| 2N4123 | MPS3640 | MPS-D06 |
| 2N4124 | MPS3646 | MPS-D51 |
| 2N4125 | MPS3702 | MPS-D52 |
| 2N4126 | MPS3704 | MPS-D53 |
| 2N4264 | MPS6507 | MPS-D55 |
| 2N4265 | MPS6511 | MPS-D56 |
| 2N4400 | MPS6514 | MPS-H02 |
| 2N4401 | MPS6515 | MPS-H04 |
| 2N4402 | MPS6518 | MPS-H05 |
| 2N4403 | MPS6519 | MPS-H07 |
| 2N5086 | MPS6520 | MPS-H08 |
| 2N5087 | MPS6621 | MPS-H10 |
| 2N5088 | MPS6522 | MPS-H11 |
| 2N5089 | MPS6523 | MPS-H17 |
| 2N5209 | MPS6531 | MPS-H20 |
| 2N5210 | MPS6534 | MPS-H24 |
| 2N5220 | MPS6535 | MPS-H30 |
| 2N5221 | MPS6541 | MPS-H31 |
| 2N5225 | MPS6543 | MPS-H32 |
| 2N5226 | MPS6546 | MPS-H34 |
| 2N5400 | MPS6547 | MPS-H37 |
| 2N5401 | MPS6566 | MPS-H54 |
| 2N5402 | MPS6568 | MPS-H55 |
| 2N5403 | MPS6569 | MPS-H81 |
| 2N5500 | MPS6570 | MPS-H83 |
| 2N5551 | MPS6571 | MPS-H85 |
| 2N6548 | MPS8097 | MPS-L01 |
| 2N6549 | MPS8098 | MPS-L51 |
| 2N6515 | MPS8099 | MPS-U01 |
| 2N6518 | MPS8500 | MPS-U01A |
| 2N6517 | MPS8590 | MPS-U03 |
| 2N6518 | MPS-A05 | MPS-U04 |
| 2N6519 | MPS-A06 | MPS-U05 |
| 2N6520 | MPS-A09 | MPS-U06 |
| 2N6551 | MPS-A17 | MPS-U07 |
| 2N6552 | MPS-A18 | MPS-U10 |
| 2N6553 | MPS-A19 | MPS-U45 |
| 2N6554 | MPS-A20 | MPS-U51 |
| 2N6555 | MPS-A42 | MPS-U51A |
| 2N6556 | MPS-A43 | MPS-U52 |
| 2N6557 | MPS-A55 | MPS-U55 |
| 2N6558 | MPS-A58 | MPS-U56 |
| 2N6559 | MPS-A70 | MPS-U57 |
| MPS708A | MPS-A92 | MPS-U60 |
| MPS834 | MPS-A93 | MPS-U95 |
| MPS835 | | |

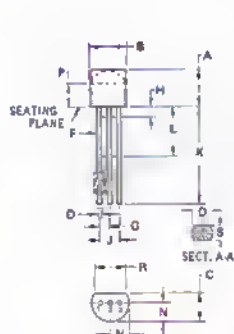
PLASTIC ENCAPSULATED SMALL-SIGNAL TRANSISTORS (Continued)

This Selector Guide is designed to help you select the right silicon plastic transistor for your applications. A wide range of device types in three basic package configurations are listed in this Selector Guide.

The TO-92 — Is the most popular, high-volume plastic package and will meet most of your high-performance, low-cost requirements.

The Uniwatt/Duowatt Package — is designed for applications requiring greater power dissipation than available with the TO-92 package.

MOTOROLA PLASTIC PACKAGE OUTLINES



Case 29-02
TO-92

| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|------|--------|-------|
| | MIN | MAX | MIN | MAX |
| A | 4.32 | 5.33 | 0.170 | 0.210 |
| B | 4.44 | 5.71 | 0.175 | 0.225 |
| C | 3.16 | 4.19 | 0.125 | 0.165 |
| D | 0.41 | 0.56 | 0.016 | 0.022 |
| E | 0.41 | 0.48 | 0.016 | 0.019 |
| F | 1.14 | 1.40 | 0.045 | 0.055 |
| H | — | 2.54 | — | 0.100 |
| J | 9.45 | 2.67 | 0.055 | 0.105 |
| K | 12.70 | — | 0.500 | — |
| L | 0.25 | — | 0.010 | — |
| M | 2.03 | 2.92 | 0.080 | 0.115 |
| P | 2.92 | — | 0.115 | — |
| R | 0.25 | — | 0.010 | — |
| S | 0.25 | — | 0.010 | — |

ALL JEDEC dimensions and notes apply

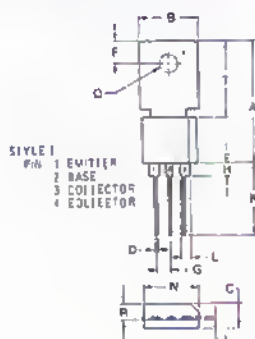


STYLE 1
1. EMITTER
2. BASE
3. COLLECTOR

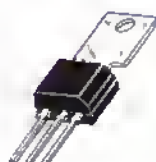
Uniwatt
Case 152-02

| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|-------|-----------|-------|
| | MIN | MAX | MIN | MAX |
| A | 8.14 | 8.63 | 0.320 | 0.339 |
| B | 6.99 | 7.24 | 0.275 | 0.286 |
| C | 5.41 | 5.66 | 0.213 | 0.223 |
| D | 0.38 | 0.52 | 0.015 | 0.021 |
| E | 3.16 | 3.32 | 0.125 | 0.131 |
| F | 2.54 BSC | — | 0.100 BSC | — |
| G | 3.50 | 4.19 | 0.138 | 0.165 |
| H | 1.78 | — | 0.070 | — |
| I | 12.70 | — | 0.500 | — |
| J | 25.52 | 25.52 | 0.995 | 1.000 |
| K | 5.08 BSC | — | 0.200 BSC | — |
| L | 2.29 | — | 0.090 | — |
| M | 1.27 | — | 0.050 | — |

NOTE
1. LEADS WITHIN 0.15 mm (0.006)
TOTAL OF TRUE POSITION
AT CASE AT MAXIMUM
MATERIAL CONDITION



STYLE 1
1. EMITTER
2. BASE
3. COLLECTOR
4. COLLECTOR



Duowatt
Case 306-02

| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|-------|--------|-------|
| | MIN | MAX | MIN | MAX |
| A | 21.84 | 22.15 | 0.860 | 0.870 |
| B | 9.11 | 9.41 | 0.359 | 0.371 |
| C | 4.13 | 4.44 | 0.163 | 0.175 |
| D | 0.61 | 0.71 | 0.024 | 0.028 |
| E | 2.68 | 3.94 | 0.105 | 0.155 |
| F | 2.41 | 2.67 | 0.095 | 0.105 |
| G | 1.70 | 1.95 | 0.067 | 0.077 |
| H | 0.49 | 0.65 | 0.019 | 0.026 |
| I | 12.70 | — | 0.500 | — |
| J | 1.78 | 2.03 | 0.070 | 0.080 |
| K | 9.11 | 10.16 | 0.359 | 0.400 |
| L | 3.56 | 3.81 | 0.140 | 0.150 |
| M | 9.11 | 2.67 | 0.095 | 0.105 |
| N | 13.21 | 13.97 | 0.520 | 0.550 |

General Purpose Amplifiers and Switches —TO-92 Package

Silicon transistors designed for use in complementary amplifier circuits. The transistors are listed in order of decreasing breakdown voltage (BV_{CEO}).

The following devices are the most popular consumer amplifier transistors:

| Device and Polarity | | BV_{CEO} Volts Min | f_T MHz @ $I_C = 10 \text{ mA}$ Min Typ* | I_C mA Max | h_{FE} | | @ I_C mA |
|---------------------|---------|----------------------------|---|--------------------|----------|-----|------------------|
| NPN | PNP | | | | Min | Max | |
| MPS8098 | MPS8598 | 60 | 200 | 500 | 100 | 300 | 10 |
| 2N3903 | 2N3905 | 40 | 270* | 200 | 50 | 150 | 10 |
| 2N3904 | 2N3906 | 40 | 250 | 200 | 100 | 300 | 10 |
| MPS3903 | MPS3905 | 40 | 150 | 200 | 50 | 150 | 10 |
| MPS3904 | MPS3906 | 40 | 200 | 200 | 100 | 300 | 10 |
| 2N4123 | 2N4125 | 30 | 250 | 200 | 50 | 150 | 2.0 |
| 2N4124 | 2N4126 | 25 | 300 | 200 | 120 | 360 | 2.0 |
| MPS6515 | MPS6519 | 25 | 100 | — | 250 | 500 | 2.0 |

The following devices are the most popular consumer low-noise transistors:

| Device and Polarity | | BV_{CEO} Volts Min | f_T MHz @ $I_C = 300 \mu\text{A}$ Min | I_C mA Max | h_{FE} | | @ I_C μA | NF dB Typ |
|---------------------|--------|----------------------------|--|--------------------|----------|------|-----------------------------|-----------------|
| NPN | PNP | | | | Min | Max | | |
| MPS-A18 | | 45 | 100 | 200 | 500 | 1500 | 10 | 4.0 |
| 2N5086 | 2N5086 | 30 | 40 | 50 | 150 | 500 | 100 | 3.0 |
| 2N5089 | 2N5087 | 25 | 40 | 50 | 250 | 800 | 100 | 2.0 |

The following are the most popular Industrial high-voltage and high current transistors:

| Device and Polarity | | BV_{CEO} Volts Min | f_T MHz Typ* | @ I_C mA | I_C mA Max | h_{FE} | |
|---------------------|---------|----------------------------|----------------------|------------------|--------------------|-----------------------------------|-----|
| NPN | PNP | | | | | Min @ $I_C = 10 \text{ mA}$ | Max |
| 2N5551 | 2N5401 | 160 | 100 | 10 | 600 | 80 | 250 |
| 2N5550 | 2N5400 | 140 | 100 | 10 | — | 40 | 180 |
| MPS-A06 | MPS-A56 | 80 | 100 | 100 | 500 | 50 | — |
| MPS-A05 | MPS-A55 | 80 | 100 | 100 | 500 | 50 | — |
| 2N4400 | 2N4402 | 40 | 200 | 20 | — | 40 | — |
| 2N4401 | 2N4403 | 40 | 250 | 20 | — | 40 | — |
| MPS6531 | MPS6534 | 40 | 390* | 50 | — | 80 | 120 |

RF/UHF/VHF Amplifiers and CATV Transistors

The transistors listed below are the high performance, high frequency standard transistors available in the TO-92 plastic package. The transistors are listed in order of decreasing breakdown voltage (V_{CE0}).

| Device Type | V_{CE0} Volts Min | f_{FE} Min | @ I _C mA | G_{dB} G_{dB} dB Typ# Min | NF dB Typ# Max | @ f MHz | V_{ACC} I_{ACC} # Typ# Min | @ Gain Reduction dB | f _T MHz Min | @ I _C mA | C_{ce} pF Max |
|-------------|---------------------------|-----------------|---------------------------|---|-------------------------|---------------|--|------------------------------|------------------------------|---------------------------|-----------------------|
| NPN | | | | | | | | | | | |
| MPS-H04 | 80 | 30 | 1.5 | — | 2.0 | 1.0 | — | — | 80 | 1.5 | 1.8 |
| MPS-H05 | 80 | 30 | 1.5 | — | 2.0 | 1.0 | — | — | 80 | 1.5 | 1.6 |
| MPS-H34 | 45 | 15 | 20 | — | — | — | — | — | 500 | 15 | 0.32 |
| MPS-H37 | 40 | 25 | 5.0 | — | — | — | — | — | 300 | 5.0 | 100 |
| MPS-H07 | 30 | 20 | 3.0 | 18* | 3.2 | 100 | 5.0* | 30 | 400 | 3.0 | 0.3* |
| MPS-H08 | 30 | 20 | 3.0 | 14* | 3.5 | 200 | 5.0* | 30 | 500 | 3.0 | 0.3* |
| MPS-H20 | 30 | 25 | 4.0 | — | — | — | — | — | 400 | 4.0 | 0.65 |
| MPS-H24 | 30 | 30 | 8.0 | — | — | — | — | — | 400 | 6.0 | 0.36 |
| MPS-H32 | 30 | 27 | 4.0 | 22.5 | 3.3* | 45 | 5.5# | 30 | 300 | 4.0 | 0.22 |
| MPS-H10 | 25 | 80 | 4.0 | — | — | — | — | — | 650 | 4.0 | 0.7 |
| MPS-H11 | 25 | 80 | 4.0 | — | — | — | — | — | 650 | 4.0 | 0.7 |
| MPS-H19 | 25 | 45 | 4.0 | — | — | — | — | — | 300 | 4.0 | 0.65 |
| MPS-H02 | 20 | 20 | 4.0 | 20 | 3.3 | 200 | 4.0 | 30 | 375 | 4.0 | 0.5 |
| MPS-H30 | 20 | 20 | 4.0 | 22.5 | 6.0 | 45 | 4.4 | 30 | 300 | 4.0 | 0.65 |
| MPS-H31 | 20 | 20 | 4.0 | 22.5 | 6.0 | 45 | 5.2 | 30 | 300 | 4.0 | 0.65 |
| MPS-H17 | 15 | 25 | 5.0 | 24# | 6.0 | 200 | — | — | 800 | 5.0 | 0.9 |

| | | | | | | | | | | | |
|------------|----|----|-----|-----|-----|-----|------|----|-----|-----|-------|
| PNP | | | | | | | | | | | |
| MPS-H54 | 80 | 30 | 1.5 | — | 2.0 | 1.0 | — | — | 80 | 1.5 | 1.8 |
| MPS-H55 | 80 | 30 | 1.5 | — | 2.0 | 1.0 | — | — | 80 | 1.5 | 1.6 |
| MPS-H83 | 30 | 20 | 2.5 | 10* | 6.5 | 850 | 4.5* | 30 | 600 | 2.5 | 0.3* |
| MPS-H85 | 30 | 20 | 2.5 | 14* | 6.5 | 200 | — | — | 350 | 2.5 | 0.2* |
| MPS6543 | 25 | 25 | 4.0 | — | — | — | — | — | 750 | 4.0 | — |
| MPS6546 | 25 | 20 | 2.0 | — | — | — | — | — | 600 | 2.0 | 0.45* |
| MPS6547 | 25 | 20 | 2.0 | 20 | — | 100 | — | — | 600 | 2.0 | 0.35* |
| MPS6568 | 20 | 20 | 4.0 | 20 | 3.3 | 200 | 4.0 | 30 | 375 | 4.0 | 0.5 |
| MPS6569 | 20 | 20 | 4.0 | 20 | 6.0 | 45 | 4.4 | 30 | 300 | 4.0 | 0.5 |
| MPS6570 | 20 | 20 | 4.0 | 20 | 6.0 | 45 | 5.2 | 30 | 300 | 4.0 | 0.5 |
| MPS6507 | 20 | 25 | 2.0 | — | — | — | — | — | 700 | 10 | — |
| MPS6511 | 20 | 25 | 10 | 30 | — | 4.5 | — | — | — | — | — |
| MPS6541 | 20 | 25 | 4.0 | — | — | — | — | — | — | — | — |

High-Speed Saturated Switching Transistors

The transistors listed in this table are specially optimized for high-speed saturated switches. They are heavily gold doped and processed to provide very short switching times and low output capacitance (below 6 pF). The transistors are listed in order of decreasing turn-on time (t_{on}).

| Device Type | t_{on} ns Max | t_{off} ns Max | @ I _C mA | V_{CE0} Volts Min | f_{FE} Min | @ I _C mA | $V_{CE(sat)}$ Volts @ I _C & I _E Max | I _E mA | f _T MHz Min | @ I _C mA |
|-------------|-----------------------|------------------------|---------------------------|---------------------------|-----------------|---------------------------|---|----------------------|------------------------------|---------------------------|
| NPN | | | | | | | | | | |
| MPS706.A | 40 | 75 | 10 | 15 | 20 | 10 | 0.6 | 10 | 1.0 | 200 |
| 2N4264 | 25 | 35 | 10 | 15 | 40 | 10 | 0.22 | 10 | 1.0 | 300 |
| 2N4265 | 25 | 35 | 10 | 12 | 100 | 10 | 0.22 | 10 | 1.0 | 300 |
| MPS835 | 20 | 35 | 10 | — | 20 | 10 | 0.3 | 10 | 1.0 | 300 |
| MPS3646 | 18 | 28 | 300 | 15 | 30 | 30 | 0.2 | 30 | 3.0 | 350 |
| MPS894 | 16 | 30 | 10 | — | 25 | 10 | 0.25 | 10 | 1.0 | 350 |
| MPS2369 | 12 | 18 | 10 | 15 | 40 | 10 | 0.25 | 10 | 1.0 | 500 |
| PNP | | | | | | | | | | |
| MPS3640 | 25 | 35 | 50 | 12 | 30 | 10 | 0.2 | 10 | 1.0 | 500 |
| MPS3639 | 25 | 25 | 50 | 6.0 | 30 | 10 | 0.16 | 10 | 1.0 | — |

General-Purpose Transistors

These general-purpose transistors are designed for small-signal amplification from dc to low radio frequencies. They are also useful as oscillators and general-purpose switches. The transistors are listed in order of decreasing breakdown voltage (BV_{CE0}).

| Device and Polarity | | BV_{CE0} Volts Min | f_T MHz Min | @ I_C mA | I_C mA Max | r_{FE} | | @ I_C mA |
|---------------------|---------|----------------------------|---------------------|------------------|--------------------|----------|-----|------------------|
| NPN | PNP | | | | | Min | Max | |
| MPS8099 | MPS8599 | 80 | 150 | 10 | 200 | 100 | 300 | 1.0 |
| MPS-A06 | MPS-A56 | 80 | 100 | 10 | 500 | 50 | — | 100 |
| MPS8098 | MPS8598 | 60 | 150 | 10 | 200 | 100 | 300 | 1.0 |
| MPS-A05 | MPS-A55 | 80 | 100 | 10 | 500 | 50 | — | 100 |
| 2N3904 | 2N3906 | 40 | 300 | 10 | 200 | 100 | 300 | 10 |
| 2N4401 | 2N4403 | 40 | 250 | 20 | 600 | 100 | 300 | 150 |
| 2N3903 | 2N3905 | 40 | 250 | 10 | 200 | 50 | 150 | 10 |
| 2N4400 | 2N4402 | 40 | 200 | 20 | 600 | 50 | 150 | 150 |
| MPS-A20 | MPS-A70 | 40 | 125 | 5.0 | 100 | 40 | 400 | 5000 |
| MPS6531 | MPS6534 | 40 | — | 50 | 600 | 100 | 300 | 150 |
| MPS2222 | MPS2907 | 30 | 250 | 20 | 600 | 100 | 300 | 150 |
| 2N4123 | 2N4125 | 30 | 250 | 10 | 200 | 50 | 150 | 2.0 |
| MPS3704 | MPS3702 | 30 | 100 | 50 | 600 | 100 | 300 | 50 |
| 2N4124 | 2N4126 | 25 | 300 | 10 | 300 | 120 | 380 | 2.0 |
| MPS-D06 | MPS-D56 | 25 | 100 | 10 | 50 | 50 | — | 10 |
| MPS-D05 | MPD-D55 | 25 | 100 | 50 | 500 | 80 | — | 100 |
| 2N5225 | 2N5226 | 25 | 50 | 20 | 200 | 30 | 600 | 50 |
| MPS6514 | MPS6518 | 25 | 200 | 10 | 200 | 50 | 300 | 10 |
| 2N5220 | 2N5221 | 15 | 100 | 20 | 500 | 30 | 600 | 50 |

Low-Noise Amplifier Transistors

The small-signal transistors listed in this table are characterized for low-noise amplification at low frequencies. The transistors are listed in decreasing order of noise figure (NF).

| Device Type | NF dB Typ | @ f kHz* | BV_{CEO} Volts Min | h_{FE} Min | @ I_C mA | f_T MHz Min | @ I_C mA |
|-------------|-----------|----------|----------------------|--------------|------------|---------------|------------|
| NPN | | | | | | | |
| 2N4123 | 6.0 | Audio | 30 | 50 | 2.0 | 250 | 10 |
| 2N3903 | 6.0 | Audio | 40 | 50 | 10 | 250 | 10 |
| 2N4124 | 5.0 | Audio | 25 | 120 | 2.0 | 300 | 10 |
| 2N3904 | 5.0 | Audio | 40 | 100 | 10 | 300 | 10 |
| MPS6585 | 4.0 | Audio | 45 | 40 | 10 | — | — |
| MPS6586 | 4.0 | Audio | 45 | 100 | 10 | — | — |
| 2N5209 | 3.0 | Audio | 50 | 150 | 10 | 30 | 500 |
| 2N5088 | 3.0 | Audio | 30 | 100 | 300 | 50 | 500 |
| MPS6520 | 3.0 | Audio | 25 | 200 | 2.0 | 390 | 2.0 |
| MPS6521 | 3.0 | Audio | 25 | 300 | 2.0 | 390 | 2.0 |
| 2N5210 | 2.0 | Audio | 5.0 | 250 | 10 | 30 | 500 |
| MPS8097 | 2.0 | 100 | 40 | 250 | 0.1 | 200 | 10 |
| 2N5089 | 2.0 | Audio | 25 | 400 | 10 | 50 | 500 |
| MPS-A18 | 1.5 | Audio | 45 | 500 | 10 | 100 | 1.0 |
| MPS-A09 | 1.4 | 1.0* | 50 | 100 | 0.1 | 30 | 0.5 |
| MPS6571 | 1.2 | 100 | 20 | 250 | 100 | 50 | 500 |
| PNP | | | | | | | |
| 2N4125 | 5.0 | Audio | 30 | 50 | 2.0 | 200 | 10 |
| 2N3905 | 5.0 | Audio | 40 | 50 | 10 | 200 | 10 |
| 2N3906 | 4.0 | Audio | 40 | 100 | 10 | 250 | 10 |
| 2N4126 | 4.0 | Audio | 25 | 120 | 2.0 | 250 | 10 |
| 2N5086 | 3.0 | Audio | 50 | 100 | 150 | 40 | 500 |
| MPS6522 | 3.0 | Audio | 25 | 200 | 2.0 | 340 | 2.0 |
| MPS6523 | 3.0 | Audio | 25 | 300 | 2.0 | 340 | 2.0 |
| 2N5087 | 2.0 | Audio | 50 | 250 | 10 | 40 | 500 |

* Audio = 10 Hz to 15.7 kHz.

High-Voltage Transistors

These high-voltage transistors are designed for driving neon bulbs and Nixie® indicator tubes, for direct line operation, and for other applications requiring high-voltage capability at relatively low collector current. These devices are listed in order of decreasing breakdown voltage (BV_{CEO}).

| Device Type | BV_{CEO} Volts Min | I_C Amp Max | h_{FE} Min | @ I_C mA | $V_{CE(sat)}$ Volts Max | @ I_C mA | I_P mA | f_T MHz Min | @ I_C mA |
|-------------|----------------------|---------------|--------------|------------|-------------------------|------------|----------|---------------|------------|
| NPN | | | | | | | | | |
| 2N6517 | 350 | 0.5 | 40 | 30 | 0.30 | 10 | 1.0 | 40 | 10 |
| 2N6516 | 300 | 0.5 | 45 | 30 | 0.30 | 10 | 1.0 | 40 | 10 |
| MPS-A42 | 300 | 0.5 | 40 | 10 | 0.5 | 20 | 2.0 | 50 | 10 |
| 2N6515 | 250 | 0.5 | 50 | 30 | 0.30 | 10 | 1.0 | 40 | 10 |
| MPS-A43 | 200 | 0.5 | 40 | 10 | 0.4 | 20 | 2.0 | 50 | 10 |
| MPS-D01 | 200 | 0.1 | 20 | 30 | — | — | — | 40 | 10 |
| 2N5551 | 150 | 0.6 | 80 | 10 | 0.15 | 10 | 1.0 | 100 | 10 |
| 2N5550 | 140 | 0.6 | 80 | 10 | 0.15 | 10 | 1.0 | 100 | 10 |
| MPSD-02 | 140 | 0.05 | 20 | 30 | — | — | — | 40 | 10 |
| MPS-D03 | 100 | 0.05 | 50 | 10 | 0.2 | 10 | 1.0 | 50 | 10 |
| MPS-L01 | 100 | 0.05 | 20 | 30 | — | — | — | 40 | 10 |
| PNP | | | | | | | | | |
| 2N6520 | 350 | 0.5 | 30 | 30 | 0.30 | 10 | 1.0 | 40 | 10 |
| 2N6519 | 300 | 0.5 | 45 | 30 | 0.30 | 10 | 1.0 | 40 | 10 |
| MPS-A92 | 300 | 0.5 | 40 | 10 | 0.8 | 20 | 2.0 | 50 | 10 |
| 2N6518 | 250 | 0.5 | 50 | 30 | 0.30 | 10 | 1.0 | 40 | 10 |
| MPS-A93 | 200 | 0.5 | 40 | 10 | 0.7 | 20 | 2.0 | 50 | 10 |
| MPS-D51 | 200 | 0.1 | 20 | 30 | — | — | — | 40 | 10 |
| 2N5401 | 150 | 0.6 | 80 | 10 | 0.2 | 10 | 1.0 | 100 | 10 |
| MPS-D52 | 140 | 0.05 | 20 | 30 | — | — | — | 40 | 10 |
| 2N5400 | 120 | 0.6 | 40 | 10 | 0.2 | 10 | 1.0 | 100 | 10 |
| MPS-D53 | 100 | 0.05 | 20 | 30 | — | — | — | 40 | 10 |
| MPS-L51 | 100 | 0.6 | 40 | 50 | 0.25 | 10 | 1.0 | 80 | 10 |

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Medium-Power (Uniwatt and Duowatt) Transistors

For applications requiring higher power dissipation than that of the standard Unibloc package, Motorola has developed the Uniwatt and Duowatt packages. These plastic packages are slightly larger than the TO-92 case. Without a heat sink the Uniwatt package can dissipate 1 Watt @ $T_A = 25^\circ\text{C}$; the Duowatt can dissipate 2 Watts @ $T_A = 25^\circ\text{C}$.

The transistors are listed in order of increasing collector current (I_C).

Uniwatt Transistors ($P_D = 1.0 \text{ Watt @ } T_A = 25^\circ\text{C}$)

| Device Type | I_C Avc Max | BV_{CEO} Volts Min | h_{FE} Min | @ I_C mA | $V_{CE(sat)}$ Volts Max | @ I_C mA | β | I_B mA | f_T MHz Min | @ I_C mA |
|-------------|---------------|----------------------|--------------|------------|-------------------------|------------|---------|----------|---------------|------------|
| NPN | | | | | | | | | | |
| MPS-U10 | 0.5 | 300 | 40 | 10 | 0.75 | 30 | 30 | 60 | 10 | |
| MPS-U02 | 0.8 | 40 | 50 | 150 | 0.4 | 150 | 15 | 15 | 20 | |
| MPS-U03 | 1.0 | 120 | 40 | 10 | 0.5 | 200 | 20 | 100 | 50 | |
| MPS-U04 | 1.0 | 180 | 40 | 10 | 0.5 | 200 | 20 | 100 | 50 | |
| MPS-U01 | 2.0 | 30 | 60 | 100 | 0.5 | 1000 | 100 | 50 | 50 | |
| MPS-U01A | 2.0 | 40 | 60 | 100 | 0.5 | 1000 | 100 | 50 | 50 | |
| MPS-U45 | 2.0 | 40 | 15 k | 500 | 1.5 | 1.0 | 2.0 | 100 | 200 | |
| MPS-U05 | 2.0 | 60 | 50 | 250 | 0.4 | 200 | 10 | 50 | 200 | |
| MPS-U06 | 2.0 | 80 | 50 | 250 | 0.4 | 250 | 10 | 50 | 200 | |
| MPS-U07 | 2.0 | 160 | 30 | 250 | 0.4 | 250 | 10 | 50 | 200 | |

PNP

| | | | | | | | | | | |
|----------|-----|-----|------|-----|------|------|-----|-----|-----|--|
| MPS-U60 | 0.5 | 300 | 30 | 10 | 0.75 | 20 | 2.0 | 60 | 10 | |
| MPS-U52 | 0.8 | 40 | 50 | 150 | 0.4 | 150 | 15 | 150 | 20 | |
| MPS-U51 | 2.0 | 30 | 50 | 100 | 0.7 | 1.0 | 0.1 | 50 | 50 | |
| MPS-U51A | 2.0 | 40 | 60 | 100 | 0.7 | 1.0 | 0.1 | 50 | 50 | |
| MPS-U95 | 2.0 | 40 | 15 k | 500 | 1.5 | 1000 | 2.0 | 500 | 200 | |
| MPS-U55 | 2.0 | 50 | 50 | 250 | 0.5 | 250 | 10 | 50 | 200 | |
| MPS-U56 | 2.0 | 60 | 50 | 250 | 0.5 | 250 | 10 | 50 | 200 | |
| MPS-U57 | 2.0 | 100 | 30 | 250 | 0.5 | 250 | 10 | 50 | 200 | |

Duowatt Transistors ($P_D = 2.0 \text{ Watt @ } T_A = 25^\circ\text{C}$)

| Device Type | I_C Avc Max | BV_{CEO} Volts Min | h_{FE} Min | @ I_C mA | $V_{CE(sat)}$ Volts Max | @ I_C mA | β | I_B mA | f_T MHz Min | @ I_C mA |
|-------------|---------------|----------------------|--------------|------------|-------------------------|------------|---------|----------|---------------|------------|
| NPN | | | | | | | | | | |
| 2N6557 | 0.5 | 250 | 40 | 30 | 0.6 | 30 | 3.0 | 45 | 10 | |
| 2N6558 | 0.5 | 300 | 40 | 30 | 0.6 | 30 | 3.0 | 45 | 10 | |
| 2N6669 | 0.5 | 350 | 40 | 30 | 0.6 | 30 | 3.0 | 45 | 10 | |
| 2N6551 | 1.0 | 60 | 60 | 50 | 0.5 | 250 | 10 | 75 | 100 | |
| 2N6552 | 1.0 | 80 | 60 | 50 | 0.5 | 250 | 10 | 75 | 100 | |
| 2N6553 | 1.0 | 100 | 60 | 50 | 0.5 | 250 | 10 | 75 | 100 | |
| 2N6548 | 2.0 | 40 | 25 k | 200 | 1.5 | 1.0 | 2.0 | 75 | 100 | |
| 2N6549 | 2.0 | 40 | 15 k | 200 | 1.5 | 1.0 | 2.0 | 75 | 100 | |

PNP

| | | | | | | | | | | |
|--------|-----|-----|----|----|-----|-----|----|----|-----|--|
| 2N6554 | 1.0 | 60 | 60 | 50 | 0.5 | 250 | 10 | 75 | 100 | |
| 2N6555 | 1.0 | 80 | 60 | 50 | 0.5 | 250 | 10 | 75 | 100 | |
| 2N6556 | 1.0 | 100 | 60 | 50 | 0.5 | 250 | 10 | 75 | 100 | |

FIELD-EFFECT TRANSISTORS



Motorola offers a line of field-effect transistors that encompasses the latest technology and covers the full range of FET applications. Included is a wide variety of junction FETs and MOSFETs, with N- or P-channel polarity with both single and dual gates. These FETs include devices developed for operation across the frequency range from dc to UHF in switching and amplifying applications. Package options from low cost plastic to metal TO-72 packages are available.

The selector guides on the following pages are designed to emphasize those FET families and device types that, by virtue of widespread industry use, ease of manufacture and, consequently, low relative cost, merit first consideration for new equipment design.

TABLE OF CONTENTS

| | Page |
|---|------|
| General-Purpose Devices | 4-30 |
| Designed for use in general-purpose amplifier and switching applications. | |
| General-Purpose Amplifiers | 4-31 |
| Transistors designed for amplification in the audio-frequency range. | |
| Choppers and Switches | 4-32 |
| Devices designed for chopper and high-speed switching applications. | |
| RF Amplifiers | 4-33 |
| Devices characterized for operation at frequencies as high as 900 MHz. | |

The following index reflects the devices characterized in this section. To locate the exact page number, see Catalog Index (Page 7-1).

INDEX

| | | | | |
|---------|---------|--------|--------|---------|
| 2N3330 | 2N4221A | 2N5460 | 2N5639 | MFE132 |
| 2N3365 | 2N4222 | 2N5461 | 2N5640 | MFE140 |
| 2N3366 | 2N4222A | 2N5462 | 2N5716 | MFE590 |
| 2N3367 | 2N4351 | 2N5474 | 2N5717 | MFE591 |
| 2N3796 | 2N4352 | 2N5475 | 2N5718 | MFE823 |
| 2N3797 | 2N4416 | 2N5476 | 2N5797 | MFE824 |
| 2N3823 | 2N4416A | 2N5484 | 2N5798 | MFE3001 |
| 2N3993 | 2N4856 | 2N5485 | 2N5799 | MFE3002 |
| 2N3994 | 2N4857 | 2N5486 | 2N5800 | MFE3003 |
| 2N3994A | 2N4858 | 2N5556 | 3N209 | MPF102 |
| 2N4220 | 2N5457 | 2N5557 | 3N223 | MPF256 |
| 2N4220A | 2N5458 | 2N5558 | MFE130 | MPF970 |
| 2N4221 | 2N5459 | 2N5638 | MFE131 | MPF971 |

THE TO-18 AND TO-72 — are designed for applications requiring hermeticity as well as greater power dissipation than available with the TO-92 package.



TO-72
CASE 20



TO-18
CASE 22



THE MICRO-H CASE 262 — four leaded plastic stripline package.

THE TO-76 is the EIA standard part for matched dual transistors.



TO-76
CASE 642

THE TO-92 — is the most popular, high-volume plastic package and will meet most of your high-performance, low-cost requirements.



TO-92
CASE 29

General-Purpose Devices

Using the same transistor for both switching and amplifier applications can reduce inventories and increase purchase quantities to take advantage of quantity price reductions. Transistors listed here represent good, all-around amplifiers in the audio frequency range, and provide satisfactory medium-speed switching capabilities. MOSFETs listed are characterized primarily as switches but can be used as satisfactory general-purpose amplifiers.

JFETs — N-CHANNEL

| Package | Family | Preferred Types | Features | V_{IS} mmhos Min/Max | I_{DSS} mA Min/Max | $V_{IBRIGSS}$ $V_{(BR)DSS}^*$ Volts Min | $V_{GS(off)}$ $V_{GS(TH)}^*$ Volts Min/Max | NF dB nV/\sqrt{Hz}^* |
|---------|--------|-------------------------------|---|------------------------------|----------------------------|--|---|------------------------------|
| TO-92 | 131 | Standard Family Limits | | 0.5/6.6 | 0.5/24 | to -50 | -0.2/-8.0 | to 2.5 |
| | | 2N5457 | Good overall performance. | 1.0/5.0 | 1.0/5.0 | -25 | -0.5/-6.0 | — |
| | | 2N5458 | Low Cost. | 1.5/5.5 | 2.0/9.0 | -25 | -1.0/-7.0 | — |
| | | 2N5459 | | 2.0/6.0 | 4.0/16 | -25 | -2.0/-8.0 | — |
| TO-72 | 130 | 2N4220 | Somewhat improved specifications, slightly higher cost. | 1.0/4.0 | 0.5/3.0 | -30 | -/-4.0 | 2.5 |
| | | 2N4221 | | 2.0/5.0 | 2.0/6.0 | -30 | -/-6.0 | 2.5 |
| | | 2N4222 | | 2.5/6.0 | 5.0/15 | -30 | -/-8.0 | 2.5 |
| | | 2N3823 | | 3.5/6.5 | 4.0/20 | -30 | -/-8.0 | 2.5 |
| | | 2N3824 | | — | — | -50 | — | — |

JFETs — P-CHANNEL

| | | | | | | | | |
|-------|-----|-------------------------------|-----------------------------|---------|---------|-------|----------|------|
| TO-92 | 125 | Standard Family Limits | | 0.8/8.0 | 0.3/30 | to 60 | -0.2/9.0 | 115* |
| | | 2N5460 | Good performance, low cost. | 1.0/4.0 | 1.0/5.0 | 40 | 0.75/6.0 | 115* |
| | | 2N5461 | | 1.5/5.0 | 2.0/9.0 | 40 | 1.0/7.5 | 115* |
| | | 2N5462 | | 2.0/6.0 | 4.0/16 | 40 | 1.8/9.0 | 115* |

MOSFET — N-CHANNEL (Enhancement)

| | | | | | | | | |
|-------|-----|-------------------------------|---|-------|------|-----|----------|---|
| TO-72 | 122 | Standard Family Limits | | 1.0/- | 10/- | 25* | 0.5/5.0* | — |
| | | 2N4351 | Relatively low-cost, complement to 2N4352 | 1.0/- | 10/- | 25* | 0.5/5.0* | — |

MOSFET — P-CHANNEL (Enhancement)

| | | | | | | | | |
|-------|-----|-------------------------------|---|---------|----------|---------|------------|---|
| TO-72 | 123 | Standard Family Limits | | 1.0/4.0 | -1.0/-10 | to -80* | -1.0/-5.0* | — |
| | | 2N4352 | Relatively low-cost, complement to 2N4351 | 1.0/- | -10/- | -25* | -1.0/-5.0* | — |

General-Purpose Amplifiers

The following transistors are designed for amplification in the audio-frequency range. The devices characterized represent the best values and should receive primary consideration. Other family members are also indicated, together with any specific features they may have.

J FET — N-CHANNEL

| Package | Family | Preferred Types | Features | V_{IS} mmhos Min/Max | I_{DSS} mA Min/Max | $V_{(BR)GSS}$ $V_{(BR)DSS}^*$ V Min | $V_{GS(off)}$ V Min/Max | NF dB nV/\sqrt{Hz}^* |
|---------|--------|-------------------------------|---|------------------------------|----------------------------|--|-------------------------------|------------------------------|
| TO-92 | 131 | Standard Family Limits | | 0.5/6.5 | 0.5/24 | 10-80 | -0.2/-0.6 | 10-75* |
| | | 2N5457 | Lowest Cost Family. | 1.0/5.0 | 1.0/5.0 | -25 | -0.5/-6.0 | — |
| | | 2N5456 | General-purpose application. | 1.5/5.5 | 2.0/9.0 | -25 | -1.0/-7.0 | — |
| | | 2N5459 | | 2.0/6.0 | 4.0/16 | -25 | -2.0/-8.0 | — |
| TO-72 | | 2N4220A | Similar to above series, but | 1.0/4.0 | 0.6/3.0 | -30 | -/-4.0 | 2.5 |
| | | 2N4221A | with specified NF and | 2.0/5.0 | 2.0/5.0 | -30 | -/-5.0 | 2.5 |
| | | 2N4222A | slightly improved specifications. Somewhat higher cost. | 2.5/6.0 | 5.0/15 | -30 | -/-8.0 | 2.5 |
| | | 2N5556 | Very low noise. | 1.5/5.5 | 0.5/2.5 | -30 | -0.2/-4.0 | 20* |
| | | 2N5557 | | 1.5/8.5 | 2.0/5.0 | -30 | -0.8/-5.0 | 20* |
| | | 2N5558 | | 1.5/6.5 | 4.0/10 | -30 | -1.5/-5.0 | 20* |
| TO-92 | 124 | Standard Family Limits | | -1.0/2.0 | 0.05/9.0 | 10-50 | -0.2/-12 | 75* |
| | | 2N5716 | For low-power applications, | 0.2/1.0 | 0.06/0.25 | -40 | -0.2/-3.0 | 75* |
| | | 2N5717 | as in battery-operated equipment. Good performance at | 0.4/1.6 | 0.2/1.0 | -40 | -0.5/5.0 | 75* |
| | | 2N5718 | low cost. | 0.5/2.0 | 0.6/4.0 | -40 | -1.0/-8.0 | 75* |
| TO-18 | | 2N3357 | Similar to above series, but | 0.1/1.0 | 0.5/0.25 | -40 | -/-2.5 | 75* |
| | | 2N3356 | higher cost due to metal | 0.25/1.0 | 0.2/1.0 | -40 | -/-7.0 | 75* |
| | | 2N3355 | package. | 0.4/2.0 | 0.8/4.0 | -40 | -/-12 | 75* |

Other Family Members

| | | | | | | | | |
|-------|-----|--|--|--|--|--|--|--|
| TO-18 | 124 | (All comparisons are referenced to similarly packaged preferred device types in the tables above.) | | | | | | |
| | | MFE2093, 4, 5 — Higher $V_{(BR)GSS}$, higher cost. | | | | | | |
| TO-72 | 131 | 2N3622, 3 — Higher $V_{(BR)GSS}$, higher cost. | | | | | | |
| | | 2N5358, 59, 80, 61, 62, 63, 64 — Tighter specifications, higher cost. | | | | | | |
| TO-92 | 131 | MPF109, MPF111 — Lowest Cost. Loose specifications. | | | | | | |

JFET — P-CHANNEL

| | | | | | | | | |
|-----------------------------|-----|--|---|------------|----------|-------|----------|--------|
| TO-92 | 125 | Standard Family Limits | | 0.8/8.0 | 0.3/3.0 | 50-60 | 0.2/9.0 | 10-3.0 |
| | | 2N5450 | Good performance, Low cost. | 1.0/4.0 | 1.0/5.0 | 40 | 0.75/6.0 | 2.5 |
| | | 2N5481 | | 1.5/5.0 | 2.0/9.0 | 40 | 1.0/7.5 | 2.5 |
| | | 2N5462 | | 2.0/6.0 | 4.0/18 | 40 | 1.8/8.0 | 2.5 |
| TO-72 | | 2N3330 | Tighter specifications, metal package, higher cost. | 1.5/3.0 | 2.0/5.0 | 20 | -/5.0 | 3.0 |
| TO-92 | 127 | Standard Family Limits | | 0.06/0.7 | 0.02/2.0 | 45 | 0.5/9.0 | 110* |
| | | 2N5797 | For low-power applications, | 0.08/0.225 | 0.02/0.1 | 40 | 0.5/4.0 | 115* |
| | | 2N5798 | as in battery-operated equipment. Good performance at | 0.1/0.4 | 0.08/0.4 | 40 | 0.8/6.0 | 115* |
| | | 2N5799 | low cost. | 0.15/0.5 | 0.25/1.0 | 40 | 1.2/6.0 | 115* |
| | | 2N5800 | | 0.25/0.7 | 0.7/2.0 | 40 | 2.0/9.0 | 115* |
| TO-72 | | 2N5474 | Similar to above series, | 0.16/0.8 | 0.2/0.5 | 40 | 1.2/7.0 | 115* |
| | | 2N5475 | higher cost due to metal | 0.2/0.5 | 0.4/1.0 | 40 | 1.6/8.0 | 115* |
| | | 2N5476 | package. | 0.26/0.65 | 0.8/2.0 | 40 | 2.0/9.0 | 115* |
| Other Family Members | | | | | | | | |
| TO-72 | 127 | (All comparisons are referenced to similarly packaged preferred device types in tables above.) | | | | | | |
| | | 2N5471, 72, 73 — Lower V_{IS} , lower I_{DSS} , higher cost. | | | | | | |
| | 125 | 2N3909, A | | | | | | |
| | | 2N5265, 66, 67, 68, 69, 70 — | | | | | | |
| | | MFE4007, 08, 09, 10, 11, 12 — | | | | | | |
| | | Very tight specifications. Higher cost. | | | | | | |
| TO-92 | 125 | 2N5463, 64, 65 — Higher $V_{(BR)GSS}$. Higher cost. | | | | | | |
| | | 2N4342, MPF151 — Low cost. | | | | | | |
| | | 2N4360 — Lowest cost. Very loose specifications. | | | | | | |

FIELD-EFFECT TRANSISTORS (continued)

General-Purpose Amplifiers (Continued)

| Package | Family | Preferred Types | Features | V_{fs} mmhos Min/Max | I_{OSS} mA Min/Max | $V_{(BR)GSS}$ $V_{(BR)OSS}^*$ V Min | $V_{GS(off)}$ V Min/Max | NF dB nV/√Hz* |
|---------|--------|-----------------|----------|------------------------------|----------------------------|--|-------------------------------|---------------------|
|---------|--------|-----------------|----------|------------------------------|----------------------------|--|-------------------------------|---------------------|

MOSFET - N-CHANNEL [Depletion-Enhancement] - TABLE II (continued)

| TO-18 | 110 | Standard Family Limits | | 0.7/4.0 | 0.5/15 | 10/20* | $V_{GS(TH)}$ -/-8.0 | 10/3.8 |
|-------|-----|-----------------------------|--|-------------------------------|-------------------------------|-----------------|----------------------------|-------------------------|
| | | MFE824 | Especially suited for smoke detector applications. | 1.0/- | 1.0/15 | 20* | -/-6.0 | - |
| TO-72 | | MFE3001 2N3796 2N3797 | $I_{GSS} = \pm 1.0 \mu A$ Max | 0.7/3.6 0.9/1.8 1.5/3.0 | 0.5/5.0 0.5/3.0 2.0/6.0 | 20* 25 20 | -/-8.0 -/-4.0 -/-7.0 | - 3.8 Typ 3.8 Typ |

MOSFET - P-CHANNEL [Enhancement]

| | | | | | | | | |
|-------|------|--------|---|-------|-------|------|-----------|---|
| TO-18 | 123A | MFE823 | Especially suited for smoke detector applications. $I_{GSS} = \pm 1.0 \mu A$ Max | 1.0/- | -/-20 | -25* | -2.0/-6.0 | - |
|-------|------|--------|---|-------|-------|------|-----------|---|

Choppers and Switches

FETs have no offset voltages and low "on" resistance. As a result they are especially well suited for chopper/switch applications. The following characterized devices represent the best values and should receive primary consideration.

JFETs - N-CHANNEL

| Package | Family | Preferred Types | Features | $I_{ds(on)}$ Ohms Max | $I_{O(off)}$ I_{OSS}^* nA Max | C_{iss} pF Max | $V_{(BR)GSS}$ $V_{(BR)OSS}^*$ V Min | $V_{GS(off)}$ $V_{GS(TH)}^*$ V Min/Max |
|----------------------|--------|--|---|-----------------------------|--|------------------------|--|---|
| TO-92 | 140 | Standard Family Limits | | 25 to 100 | 0.25 to 1 | 3.5 to 8.0 | 10 to -40 | -0.6/-10 |
| | | 2N5638 | Good Performance, low cost. | 30 | 1.0 | 4.0 | -30 | — |
| | | 2N5539 | | 60 | 1.0 | 4.0 | -30 | — |
| | | 2N5640 | | 100 | 1.0 | 4.0 | -30 | — |
| TO-18 | | 2N4856 | Somewhat improved specifications. Metal Package | 25 | 0.25 | 8.0 | -40 | -4.0/-10 |
| | | 2N4857 | | 40 | 0.25 | 8.0 | -40 | -2.0/-6.0 |
| | | 2N4858 | Higher cost | 50 | 0.25 | 8.0 | -40 | -0.8/-4.0 |
| Other Family Members | | | | | | | | |
| TO-92 | 140 | MPF4391, 2, 3 — Similar to 2N5638 Series, slightly higher cost. | | | | | | |
| TO-18 | | 2N4091, 2, 3 — Slower than 2N4856 Series, slightly lower cost. 2N4391, 2, 3 — Slightly improved performance, out higher cost. 2N4859, 60, 61 — Same as 2N4856, 57, 58 except for $\pm 30 V_{(BR)GSS}$. 2N4856A, 57A, 58A, 59A, 60A, 61A — Tighter C_{iss} than non-A version. 2N3970, 71, 72 — MFE2004, 6, 6. | | | | | | |
| Other Family Members | | | | | | | | |
| TO-72 | 136 | MFE2010, 1, 2 — Lower $I_{ds(on)}$, significantly higher cost | | | | | | |

JFETs - P-CHANNEL

| | | | | | | | | |
|-------|-----|------------------------|-----------------------------|------------|-----|------------|----|---------|
| TO-92 | 128 | Standard Family Limits | | 100 to 250 | 10 | 5.0 | 30 | 1.0/12 |
| | | MPF970 | Good Performance, low cost. | 100 | 10 | 5.0 | 30 | 5.0/12 |
| | | MPF971 | | 250 | 10 | 5.0 | 30 | 1.0/7.0 |
| TO-72 | 129 | Standard Family Limits | | 150 to 300 | 1.2 | 3.5 to 5.0 | 25 | 1.0/9.5 |
| | | 2N3993 | Higher cost than above | 150 | 1.2 | 4.6 | 25 | 4.0/9.5 |
| | | 2N3994 | plastic series. | 300 | 1.2 | 5.0 | 25 | 1.0/5.6 |
| | | 2N3994A | | 300 | 1.2 | 3.5 | 25 | 1.0/5.5 |

MOSFET - N-CHANNEL [Enhancement]

| | | | | | | | | |
|----------------------|-----|---|--|------------|-----|-----|-----|----------|
| TO-72 | 122 | Standard Family Limits | | 100 to 300 | 10* | 1.3 | 25* | 0.5/5.0* |
| | | 2N4351 | Relatively low cost. Complementary with 2N4352 P-Channel device. | 300 | 10* | 1.3 | 25* | 1.0/5.0* |
| | 114 | MFE3002 | Somewhat higher cost. | 100 | 10* | 1.0 | 15* | -/3.0* |
| Other Family Members | | | | | | | | |
| TO-72 | 122 | 3N169, 170, 171 - Tighter $V_{GS(TH)}$, higher cost. | | | | | | |

MOSFET - P-CHANNEL [Enhancement]

| | | | | | | | | |
|----------------------|-----|---|----------------------|------------|-------------|----------|---------|------------|
| TO-72 | | Standard Family Limits | | 200 to 600 | 0.25 to 10* | 1 to 1.3 | 10/-60* | -1.0/-5.0* |
| | 123 | 2N4352 | Relatively Low cost | 600 | -10* | 1.3 | 25* | -1.0/-5.0* |
| | 115 | MFE3003 | Slightly Higher cost | 200 | -10* | 1.0 | 15* | -/-4.0* |
| Other Family Members | | | | | | | | |
| TO-72 | 123 | 3N165, 55A, 56, 56A, 57, 57A, 58, 58A - Tighter parameter limits, higher cost | | | | | | |

RF Amplifiers

Devices listed here are characterized for operation at frequencies as high as 900 MHz. Both amplifier and mixer devices are included. In general, amplifier transistors have a small-signal power gain (G_{ps}) specification and a noise figure, while mixer devices are characterized by a conversion gain (G_c) specification and may or may not have an assigned noise figure.

A comparison of specifications indicates that MOSFETs, in general, have a considerably lower reverse transfer capacitance (C_{rss}) than JFETs. This makes them suitable for operation over wide frequency ranges, as required for many TV applications. Moreover, all MOSFETs listed are dual-gate devices that often simplify circuit designs. The JFET lines are often preferred for communications circuits where only narrow bandwidths are required.

JFET — N-CHANNEL

| Package | Family | Preferred Types | Features | Test Frequency MHz | G_{ps} G_c^* dB Min/Max | Y_{fs} mmhos Min/Max | C_{rss} pF Min/Max | NF dB Max | $V_{(BR)DSS}$ $V_{(BR)GSS}^*$ V Min |
|---|---------|---|---|-----------------------|--------------------------------------|------------------------------|----------------------------|-----------------|--|
| TO-92 | 130 | Standard Family Limits | | to 200 | 10/20 | 2.0/7.5 | -/3.0 | 4.0 | to 25 |
| | | MPF102 | Very low cost. Limited specifications. | 100 | - | 2.0/7.5 | -/3.0 | - | 25' |
| | 146 | Standard Family Limits | | to 400 | 10/30 | 3.0/8.0 | 1.0/3.0 | - | to 30 |
| | | 2N5484 | Moderate cost. Low noise figure. | 100 | 16/25 | 3.0/6.0 | -/3.0 | 3.0 | 25' |
| | | MPF256 | Slightly higher cost. Improved performance. | 400 | 12/- | 8.0/- | 1.2 Typ | 4.0 | 25' |
| | | 2N5485 | Somewhat higher cost. | 400 | 10/20 | 3.5/7.0 | -/1.0 | 4.0 | 25' |
| | 2N5486 | | 400 | 10/20 | 4.0/8.0 | -/1.0 | 4.0 | 25' | |
| TO-72 | 2N4416 | Best value in metal | 400 | 10/- | 4.5/7.6 | -/0.8 | 4.0 | 30' | |
| | 2N4416A | As above, but higher break-down voltage and tighter $V_{GS(off)}$ | | | | | | | |
| Other Family Members (All comparisons are referenced to similarly packaged preferred device types in the table above.) | | | | | | | | | |
| TO-92 | 130 | 2N5668, 59, 70 - Somewhat Improved specifications. Higher cost. MPF108, MPF112 - Lowest cost. Very limited specifications. | | | | | | | |
| TO-72 | | 2N4223, 24; 2N3823 | | | | | | | |
| | | 146 | MFE2000, 1 | | | | | | |
| | 120 | 3N124, 25, 26 - This family is rodder connected, and is tested at 100 MHz. Has higher breakdown voltage (50 V) and higher cost than other metal packaged devices. | | | | | | | |

MOSFET — N-CHANNEL

| AMPLIFIERS | | | | | | | | | |
|----------------------|-----|---|---------------------------------------|--------|--------|--------|---------|-----|-------|
| TO-72 | 875 | Standard Family Limits | | to 500 | 10/28 | 8.0/20 | -/-0.05 | 6.0 | to 25 |
| | | MFE130 | VHF amplifiers listed in order | 105 | 17/- | 8.0/20 | -/0.05 | 6.0 | 25 |
| | | MFE131 | of increasing test frequency. | 200 | 17/- | 8.0/20 | -/0.05 | 6.0 | 25 |
| | | 3N209 | Cost variations are relatively small. | 600 | 10/20 | 10/20 | -/0.05 | 6.0 | 25 |
| | 890 | Standard Family Limits | | to 900 | 10/- | 8.0/20 | -/0.025 | 8.0 | 25 |
| | | MFE590 | VHF/UHF amplifiers characteri- | 900 | 10.5/- | 8.0/20 | -/0.025 | 8.0 | 25 |
| | | MFE591 | zed to 900 MHz. Moderate cost. | 900 | 10.5/- | 10/20 | -/0.02 | 8.0 | 25 |
| | | | | | | | | | |
| MIXERS | | | | | | | | | |
| TO-72 | 875 | Standard Family Limits | | to 500 | 10/28 | 8.0/20 | -/0.06 | 6.0 | to 26 |
| | | MFE132 | Good performance. | 200 | 12/- | 8.0/20 | -/0.05 | - | 25 |
| | | 3N223 | Improved specifications. | 200 | 21/28' | 17/40 | -/0.05 | - | 25 |
| | | | Moderately higher cost. | | | | | | |
| Other Family Members | | | | | | | | | |
| 262 | 875 | MPF130 — Amplifier MPF131 — Amplifier 3N210 — Amplifier MPF132 — Mixer | | | | | | | |
| | 880 | 3N224 — Mixer | | | | | | | |
| TO-72 | 112 | MFE3004, 5 — Amplifier 3N128 — Amplifier | | | | | | | |
| | 816 | 3N140 — Amplifier/Mixer | | | | | | | |



MULTIPLE DEVICES

SMALL-SIGNAL MULTIPLE TRANSISTORS AND DARLINGTON TRANSISTORS

The trend in electronic system design is toward the use of integrated circuits — to reduce component cost, assembly cost, and equipment cost. But ICs still aren't all things to all people, and for those circuit designs where ICs are not available, there is a noticeable swing towards the use of multiple devices.*

Motorola is reacting to this expanding market requirement by making available a very large selection of Quad, Dual and Darlington transistors for off-the-shelf delivery. The chips used in the Quad and Dual transistors are those that have emerged as the most popular ones for discrete transistor applications. But even beyond that, Motorola offers its entire vast repertoire of discrete small-signal transistors for multiple-device packaging. For special applications where the devices listed may not quite fit the design requirements, special configurations can be supplied with quick turnaround time and low premiums.

**Multiple devices, as described here, encompass two or more transistor chips in a single package. Included in this definition are the Darlington transistors which consist of two interconnected devices functioning as a single-stage amplifier.*

TABLE OF CONTENTS

| | Page |
|--|------|
| Quad Transistors | 4-37 |
| General-Purpose Amplifier and Switching Transistors | |
| Low-Noise, High-Gain Amplifier Transistors | |
| Low-Current Switching Transistors | |
| RF Amplifiers and Oscillators, High-Voltage Drivers, and | |
| J-FET-Bipolar Transistors | |
| Dual Transistors | 4-41 |
| General-Purpose Amplifier and Switching Amplifiers | |
| Low-Noise, High-Gain Amplifier Transistors | |
| High-Current Switching and Core Driver Transistors | |
| RF Amplifiers and Oscillators | |
| Darlington Transistors | 4-45 |
| Power and Small-Signal Darlington Amplifier Transistors | |
| MPU Clock Buffer | 4-40 |

MULTIPLE TRANSISTORS (continued)

The following index reflects the devices characterized in this section. To locate the exact page number, see Catalog Index (Page 7-1).

INDEX

QUAD TRANSISTORS

2N5146
2N6501
MHQ918
MHQ2221
MHQ2222
MHQ2369
MHQ2483
MHQ2484
MHQ2906
MHQ2907
MHQ3467
MHQ3798
MHQ3799
MHQ4001A
MHQ4002A
MHQ4013
MHQ4014
MHQ6001
MHQ6002
MHQ6100
MHQ6100A
MPQ918
MPQ1000
MPQ1050
MPQ2001
MPQ2221
MPQ2222
MPQ2369
MPQ2483
MPQ2484
MPQ2906
MPQ2907
MPQ3303
MPQ3467
MPQ3546
MPQ3725
MPQ3725A
MPQ3752
MPQ3798
MPQ3799
MPQ3904
MPQ3906
MPQ4003
MPQ4004
MPQ6501
MPQ6502
MPQ6600
MPQ6600A
MPQ6700
MPQ6842
MPQ7041
MPQ7042
MPQ7043
MPQ7051
MPQ7052
MPQ7053
MPQ7091
MPQ7092

MPQ7093
MD918
MQ930
MQ982
MQ1120
MQ1129
MQ2218,A
MQ2219,A
MD2369
MQ2484
MQ2904
MQ2905A
MQ3251
MQ3467
MQ3726
MQ3762
MQ3788
MQ3799A
MQ7001
MQ7003
MQ7004
MQ7005
MQ7007

DUAL TRANSISTORS

2N2060
2N2060A
2N2223,A
2N2453,A
2N2480,A
2N2639
2N2644
2N2652,A
2N2720
2N2721
2N2722
2N2903,A
2N2913
thru
2N2920
2N3043
thru
2N3048
2N3425
2N3806
thru
2N3811
2N3811A
2N3812
thru
2N3817
2N3817A
2N3838
2N4016
2N4016
2N4854
2N4856
2N4937

2N4938
2N4939
2N4940
2N4941
2N4942
2N5973
2N5794
2N6795
2N6796
2N8428
thru
2N8435
2N8441
thru
2N8448
2N6502
2N6503
MD708,A,B
MD708F,AF,BF
MD818,A,B
MD918AF,BF
MD982
MD982F
MD994
MD985
MD985F
MD986
MD986F
MD1120
MD1120F
MD1121,F
MD1122,F
MD1123,F
MD1129
MD1128F
MD1130F
MD1131,F
MD1132,F
MD2060,F
MD2218,A
MD2218F,AF
MD2219,A
MD2219F,AF
MD2369,A,B
MD2369AF,BF
MD2904,A
MD2904F,AF
MD2905,A
MD2905F,AF
MD3260,A
MD3260F,AF
MD3261A
MD3261F,AF
MD3409
MD3410
MD3425
MD3467
MD3467F

MD3725
MD3725F
MD3762,F
MD6000,A,B
MD6001,F
MD6002,F
MD6003,F
MD6100,F
MD7000
MD7001,F
MD7002,A,B
MD7003,A,B
MD7003F,AF
MD7004,F
MD7005,F
MD7007,A,B
MD7007F,BF
MD7021,F
MD8001
MD8002
MD8003

DARLINGTON TRANSISTORS

2N998
2N2723
2N2785
2N6034
2N6035
2N6036
2N6037
2N6038
2N6039
2N6294
2N6295
2N6296
2N6297
2N6426
2N6427
MJE700
MJE702
MJE800
MJE802
MM6427
MPS-A12
MPS-A13
MPS-A14
MPS-A66
MPS-A66
MPS-D04
MPS-D54

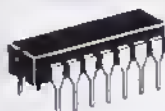
QUAD TRANSISTORS

GENERAL-PURPOSE AMPLIFIER AND SWITCHING TRANSISTORS

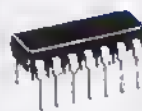
The multiple transistors included in this category have been implemented with discrete transistor chips that have proved to be the most popular for high all around performance at low cost. The line is characterized by a relatively high-current gain over an extremely wide range of dc collector current, a high-frequency response and medium-speed switching capability.



CASE 607 04
(Ceramic Flat Package)
MQ Devices



CASE 632
TO-116
(Ceramic Package)
MHQ Devices



CASE 646
(Plastic Package)
MPQ Devices

| | NPN TYPES | | | | PNP TYPES | | | |
|---|--|--------------------|---|---|---|--------------------|--|---|
| Prime Devices | MPQ2222 MHQ2222 MQ2219A (Basic Device Design — 2N2222) | | | MPO3904 (Basic Device Design 2N3904) | MPQ2907 MHQ2907 MQ2905A (Basic Device Design — 2N2907) | | | MPQ3906 (Basic Device Design 2N3906) |
| Design Parameters Specified hFE Range BVCEO fT (Typ) fmax (Typ) ton (Typ) toff (Typ) | To 60 Vdc 100 μA to 500 mA 300 MHz @ 20 mA 25 ns @ 150 mA 250 ns | | | To 40 Vdc 100 μA to 100 mA 300 MHz @ 10 mA 40 ns @ 10 mA 136 ns | To 60 Vdc 100 μA to 500 mA 350 MHz @ 50 mA 30 ns @ 150 mA 100 ns | | | To 40 Vdc 100 μA to 100 mA 350 MHz @ 10 mA 43 ns @ 10 mA 155 ns |
| Derivatives From Prime Devices (In decreasing order of price) | Ceramic Package | Plastic Package | Ceramic Flat Package | — | Ceramic Package | Plastic Package | Ceramic Flat Package | — |
| | MHQ2221 | MPQ2221 MPQ1000 | MQ2218A MQ2219 MQ1120 MQ1129 | | MHQ2906 | MPQ2906 MPQ1500 | MQ2904 MQ7001 MQ982 MQ3251 (1) MQ7007 (1) (1) See 2N3250 data sheet for basic design parameters. | |
| Complementary Pairs (2 Pairs Per Package) | Ceramic Package | | Plastic Package | Ceramic Flat Package | Description | | | |
| | MHQ6002 } MHQ6001 } | | MPQ6002 } MPQ6001 } MPQ6502 } MPQ6501 } MPQ6700 } | MQ6002 } MQ6001 } | Two Chips from Basic Device Design 2N2222 and 2N2907. Devices differ principally in hFE. Same as above, but with a different pin arrangement. Two Chips from Basic Device Design 2N3904 and 2N3906. | | | |

Numbers in italic type denote data sheet that shows design curves.

MULTIPLE TRANSISTORS (continued)
QUAD TRANSISTORS (continued)

**LOW-NOISE; HIGH-GAIN
 AMPLIFIER TRANSISTORS**

| NPN TYPES | | | PNP TYPES | | | Prime Devices |
|--|------------------------|----------------------|--|-----------------|----------------------------|---|
| MQ2484 MPQ2484 MHQ2484 (Basic Device Design - 2N2484) | | | MQ3799A (Matched) MPQ3799 MHQ3799 (Basic Device Design - 2N3799) | | | |
| To 60 Vdc 100 μ A to 10 mA 90 MHz @ 500 μ A 2.0 dB @ 10 μ A | | | To 60 Vdc 10 μ A to 10 mA 140 MHz @ 1.0 mA 1.5 dB @ 100 μ A | | | Design Parameters BV _{CEO} Specified h _{FE} Range f _T (Typ) NF (Typ) |
| Ceramic Package | Plastic Package | Ceramic Flat Package | Ceramic Package | Plastic Package | Ceramic Flat Package | Derivatives From Prime Devices (In decreasing order of price) |
| MHQ2483 | MPQ2483 | MQ930 | MHQ3798 | MPQ3798 | MQ3799 MQ3798 MQ7003 | |
| Ceramic Package | Plastic Package | Ceramic Flat Package | Description | | | Complementary Pairs |
| MHQ6100,A | MPQ6100,A MPQ6600,A | MQ6100 MQ7021 | Two Chips from Basic Device Design 2N2484 and 2N3799. The A version has higher gain. | | | |

**HIGH-CURRENT SWITCHING AND
 CORE DRIVER TRANSISTORS**

| NPN TYPES | | | | PNP TYPES | | | Prime Devices |
|---|---|--|--|-----------------|-----------------|--|--|
| MPQ3725A <i>(Basic Device Design - 2N3725)</i> | MHQ4014 <i>(Basic Device Design - 2N4014)</i> | MPQ3303 <i>(Basic Device Design 2N3303)</i> | MPQ3762 2N5146 <i>(Basic Device Design - 2N3762)</i> | | | | |
| To 50 Vdc 100 mA to 500 mA 300 MHz @ 50 mA 20 ns @ 500 mA 50 ns | To 45 Vdc 10 mA to 1.0 A 300 MHz @ 50 mA 20 ns @ 500 mA 50 ns | To 12 Vdc 100 mA to 1.0 A 500 MHz @ 100 mA 12 ns @ 1.0 A 20 ns | To 40 Vdc 100 mA to 1.0 A 200 MHz @ 50 mA 30 ns @ 500 mA 75 ns | | | Design Parameters BV _{CEO} Specified h _{FE} Range I _T (Typ) I _{on} (Typ) I _{off} (Typ) | |
| Plastic Package | Ceramic Package | Ceramic Flat Package | — | Ceramic Package | Plastic Package | Ceramic Flat Package | Derivatives From Prime Devices (In decreasing order of price) |
| MPQ3725 MPQ4004 MPQ4003 MPQ1050 | MHQ4013 MHQ4002A MHQ4001A | MQ3725 2N6501 | | MHQ3467 | MPQ3467 | MQ3467 MQ3762 | |

Numbers in italic type denote data sheet that shows design curves.

MULTIPLE TRANSISTORS (continued)
QUAD TRANSISTORS (continued)

**LOW-CURRENT
SWITCHING TRANSISTORS**

| | NPN TYPES | PNP TYPES |
|--|--|---|
| Prime Devices | MPQ2369 MQ2369 MHQ2369 <i>(Basic Device Design - 2N2369)</i> | MPQ3546 MHQ3546 <i>(Basic Device Design - 2N3546)</i> |
| Design Parameters BVCEO Specified hFE Range fT (Typ) ton (Typ) toff (Typ) | To 15 Vdc 10 mA to 100 mA 650 MHz @ 10 mA 9.0 ns @ 10 mA 15 ns | To 12 Vdc 10 mA to 100 mA 850 MHz @ 10 mA 15 ns @ 50 mA 25 ns |
| Derivative From Prime Devices | Flat Package MQ7004 | - |

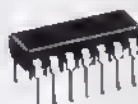
CASE 607-04
(Ceramic
Flat Package)
MQ Devices



CASE 632
TO-116
(Ceramic Package)
MHQ Devices



CASE 646
(Plastic Package)
MPQ Devices



**RF AMPLIFIERS AND OSCILLATORS,
HIGH-VOLTAGE (HV) DRIVERS, AND J-FET-BIPOLAR QUAD TRANSISTORS**

| | RF NPN TYPES | HV NPN TYPES | HV PNP TYPES |
|---|--|---|---|
| Prime Devices | MPQ918 MQ918 MHQ918 <i>(Basic Device Design - 2N918)</i> | MPQ7043 <i>(Basic Device Design - 2N6515)</i> | MPQ7093 <i>(Basic Device Design - 2N6518)</i> |
| Design Parameters BVCEO Specified hFE Range fT (Typ) NF (Typ) | To 15 Vdc 100 μ A to 10 mA 850 MHz @ 4.0 mA 4.0 dB @ 1.0 mA | To 400 Vdc** 1.0 mA to 30 mA 70 MHz @ 10 mA | To 400 Vdc** 1.0 mA to 30 mA 70 MHz @ 10 mA |
| Derivatives From Prime Devices (In decreasing order of price) | Ceramic Flat Package MQ7005 | Plastic Package MPQ7042 MPQ7041 | Plastic Package MPQ7092 MPQ7091 |
| Complementary Pairs (2 Pairs Per Package) | - | Plastic Package MPQ7051 MPQ7052 MPQ7053 | Description Two Chips from Basic Device Design 2N6515 and 2N6518. Devices differ principally in BVCEO. |
| NPN-Bipolar, N-Channel, J-FET Quad Transistor Combination | - | MPQ2001 | Two Chips from Basic Device Design 2N2222 & 2N5358 (J-FET) lines, BVGS to 25 Vdc, IDSS from 2.0 mA-16 mA |

**Supplied as Specials.

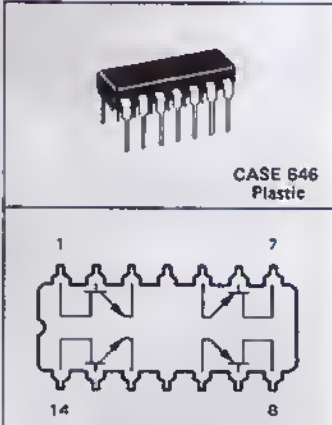
Numbers in italic type denote data sheet that shows design curves.

MPU CLOCK BUFFER

MPQ6842

Quad dual in-line silicon annular complementary pair transistors.

The MPQ6842 is designed to provide the switching speed and saturation voltages necessary to design the clock circuit to meet the MPU clock requirements.

| Design Parameters | | Limits |
|--|--------------------------|-----------------------|
| <div><p>CASE 646 Plastic</p><p>1 2 14 8</p><p>CONNECTION DIAGRAM</p></div> | BV_{CEQ} | To 40 Vdc |
| | Specified h_{FE} Range | 100 μ A to 100 mA |
| | f_T (Typ) | 300 MHz @ 10 mA |
| | t_{on} (Typ) | 45 ns @ 10 mA |
| | t_{off} (Typ) | 150 ns @ 10 mA |

DUAL TRANSISTORS

LOW-NOISE, HIGH-GAIN AMPLIFIER TRANSISTORS



CASE
610A-03
(Ceramic Package)



CASE
654-07
(Metal Package)

| | NPN TYPE | | PNP TYPE | |
|--|--|--------------------------|---|---|
| Prime Devices | 2N2920 <i>(Basic Device Design – 2N2484)</i> | | 2N3811A <i>(Basic Device Design – 2N3799)</i> | |
| Design Parameters Specified h_{FE} Range f_T (Typ) NF (Typ) h_{FE} Matching Avail. | To 60 Vdc 10 μ A to 10 mA 90 MHz @ 500 μ A 2.0 dB @ 10 μ A | | To 60 Vdc 1.0 μ A to 10 mA 140 MHz @ 1.0 mA 1.5 dB @ 100 μ A | |
| Derivatives From Prime Devices (In decreasing order of price) | Metal Package | Ceramic Package | Metal Package | Ceramic Package |
| | 2N2543,A 2N2639 thru 2N2644 2N2722 2N2903,A 2N2913 thru 2N2919 MD7002,A,B MD8001 MD8003 | 2N3043 thru 2N3048 | 2N3806 thru 2N3811 MD7003,A,B | 2N3812 thru 2N3817A MD7003F,AF |
| Complementary Pairs (Basic Device Design 2N2484 and 2N3799) | Metal Package | | Ceramic Package | |
| | MD6100 MD7021 | | MD6100F MD7021F | |
| Matched Pairs (Monolithic Devices) | Metal Package | | Description | |
| | 2N6441 thru 2N6448 | | Devices differ principally in gain and matching characteristics. | |

Numbers in italic type denote data sheet that shows design curves.

MULTIPLE TRANSISTORS (continued)

DUAL TRANSISTORS (continued)

GENERAL-PURPOSE AMPLIFIER AND SWITCHING AMPLIFIERS

The multiple transistors included in this category have been implemented with discrete transistor chips that have proved to be the most popular for high all around performance at low cost. The line is characterized by a relatively high-current gain over an extremely wide range of dc collector current, a high-frequency response and medium-speed switching capability.



| NPN TYPE | | PNP TYPE | | |
|--|--|---|--|---|
| MD2219A,AF (Basic Device Design – 2N2222) | | MD2905A,AF (Basic Device Design – 2N2907) | | Prima Devices |
| To 60 Vdc 10 μ A to 500 mA 300 MHz @ 20 mA 40 ns @ 150 mA 110 ns | | To 60 Vdc 100 μ A to 500 mA 350 MHz @ 50 mA 30 ns @ 150 mA 100 ns | | Design Parameters BV _{CEO} Specified hFE Range f _T (Typ) t _{on} (Typ) t _{off} (Typ) hFE Matching Avail. |
| Metal Package | Ceramic Package | Metal Package | Ceramic Package | Derivatives From Prima Devices (In decreasing order of price) |
| 2N2060,A 2N2223,A 2N2480,A 2N2652,A 2N2720 2N2721 2N5793 2N5794 | MD2218,AF MD2219F MD1120F MD1129F MD1120 MD1121 MD1122 MD1129 MD7000 | 2N4015 2N4016 2N5795 2N5796 MD2904,A MD2905 MD7001 MD982 | MD2904F,AF MD2905F MD7001F MD982F | |
| Metal Package | | Ceramic Flat Package | | Complementary Pairs (Basic Device Design 2N2222 and 2N2907) |
| 2N4854 2N4855 MD985 | | MD6001 MD6002 MD6003 | | |
| | | 2N3838 MD985F MD6001F MD6002F MD6003F | | |

Numbers in italic type denote data sheet that shows design curves.

MULTIPLE TRANSISTORS (continued)
DUAL TRANSISTORS (continued)

**RF AMPLIFIERS
AND OSCILLATORS**



CASE
610A-03
(Ceramic Package)



CASE
654-07
(Metal Package)



CASE
654-01
(Metal Package)

| | NPN TYPE | | PNP TYPE | |
|--|--|---|--|---|
| Prime Devices | MD918A MD918AF <i>(Basic Device Design – 2N918)</i> | | MD5000A <i>(Basic Device Design – 2N3307)</i> | |
| Design Parameters BV _{CEO} Specified h _{FE} Range f _T (Typ) NF (Typ) G _{ps} h _{FE} Matching Avail. | To 15 Vdc 100 μ A to 10 mA 850 MHz @ 4.0 mA 4.0 dB @ 1.0 mA 15 dB @ 4.0 mA | | To 15 Vdc 100 μ A to 10 mA 900 MHz @ 4.0 mA 3.0 dB @ 1.0 mA 18 dB @ 4.0 mA | |
| | Metal Package | Ceramic Package | Metal Package | — |
| Derivatives From Prime Devices (In decreasing order of price) | <i>MD918.B</i> MD1131 MD1132 MD7005 | <i>MD918F.BF</i> MD1131F MD1132F MD7005F | MD5000 MD5000B | |

NEW INTRODUCTIONS

- MD4260 PNP silicon transistors designed for use as wideband or high-frequency differential amplifiers and dual RF amplifiers.
 MD4261
 MD6900 NPN/PNP silicon transistor designed for use as complementary wideband RF amplifiers.

TO BE INTRODUCED

- MD5500,F 450 MHz NPN Amplifier

Numbers in italic type denote data sheet that shows design curves.

MULTIPLE TRANSISTORS (continued)
DUAL TRANSISTORS (continued)

**HIGH-CURRENT SWITCHING AND
CORE DRIVER TRANSISTORS**

| NPN TYPE | | PNP TYPE | | Prime Devices |
|---|-----------------|--|-----------------|---|
| MD3725,F (Basic Device Design - 2N3725) | | MD3762,F (Basic Device Design - 2N3762) | | |
| To 45 Vdc 10 mA to 1.0 A 300 MHz @ 50 mA 20 ns @ 500 mA 25 ns | | To 40 Vdc 100 mA to 1.0 A 200 MHz @ 50 mA 30 ns @ 500 mA 75 ns | | Design Parameters BVCEO Specified hFE Range fT (Typ) ton (Typ) toff (Typ) hFE Matching Avail. |
| Metal Package | Ceramic Package | Metal Package | Ceramic Package | Derivatives From Prime Devices |
| 2N6502 | 2N6503 | MD3467 | MD3467F | |

**LOW-CURRENT
SWITCHING TRANSISTORS**

| NPN TYPE | | PNP TYPE | | Prime Devices |
|--|--|---|---|---|
| MD2369A,AF (Basic Device Design - 2N2369) | | MD3251A,AF (Basic Device Design - 2N3250) | | |
| To 15 Vdc 10 mA to 100 mA 650 MHz @ 10 mA 15 ns @ 10 mA | | To 40 Vdc 10 μ A to 50 mA 300 MHz @ 10 mA 50 ns @ 10 mA 200 ns @ 10 mA | | Design Parameters BVCEO Specified hFE Range f _T (Typ) t _{on} (Typ) t _{off} (Typ) hFE Matching Avail. |
| Metal Package | Ceramic Package | Metal Package | Ceramic Package | Derivatives From Prime Devices (In decreasing order of price) |
| 2N3425 MD708,A,B MD2369,B MD7004 | MD708,AF,BF,F MD2369F,BF MD7004F | 2N4937 2N4938 2N4939 MD3250,A MD3251,A MD1123 MD1130 MD7007,A,B MD984 | 2N4940 2N4941 2N4942 MD3250F,AF MD3251F,AF MD1130F MD7007F,BF | |
| Metal Package | Ceramic Package | | Complementary Pairs (Basic Device Design 2N2369 and 2N3250) | |
| MD986 | MD986F | | | |






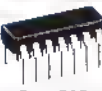
Numbers in italic type denote data sheet that shows design curves.

DARLINGTON TRANSISTORS

POWER AND SMALL-SIGNAL DARLINGTON AMPLIFIER TRANSISTORS

Darlington amplifiers are cascade transistors used in applications requiring very high-current gain and input impedance. The plastic transistors have monolithic construction and the metal package transistors are two chip construction. The transistors are listed in order of increasing breakdown voltage (BVCEO).

| BVCEs* VCE(sat) # BVCEO Volts Min | Ic mA* Amp Max | hFE @ Ic | | | VCE(sat) @ Ic | | Pd Watts | fT MHz Min | NF dB Typ | Device Type | |
|---|-------------------------|----------|---------|------------|---------------|------------|-------------|------------------|-----------------|-------------|---------|
| | | Min | Max | mA* Amp | Volts Max | mA* Amp | | | | NPN | PNP |
| 20* | 500* | 20,000 | — | 10* | 1.0 | 10* | 0.625 | 0.035 | — | MPS-A12 | — |
| 25* | 300* | 1000 | — | 10* | 1.0 | 0.1 | 0.625 | 100 | — | MPS-D04 | MPS-D54 |
| 30* | 500* | 5000 | — | 10* | 1.5 | 0.1 | 0.625 | 125 | 2.0 | MPS-A13 | — |
| 30* | 500* | 10,000 | — | 10* | 1.5 | 0.1 | 0.625 | 125 | 2.0 | MPS-A14 | — |
| 30* | 300* | 50,000 | — | 10* | 1.5 | 0.1 | 0.625 | 100 | 2.0 | — | MPS-A65 |
| 30* | 300* | 75,000 | — | 10* | 1.5 | 0.1 | 0.625 | 100 | 2.0 | — | MPS-A66 |
| 40 | 200* | 1200 | — | 10* | 1.0 | 15* | 0.5 | 10 | — | 2N2785 | — |
| 40 | 300* | 5000 | — | 10* | 1.5 | 0.1 | 0.375 | — | — | MM6427 | — |
| 40 | 500* | 5000 | — | 10* | 1.5 | 0.1 | 0.75 | — | — | MPQ6426 | — |
| 40 | 1.0 | 10,000 | 25,000 | 150* | — | — | — | 175 | 6.0 | — | 2N6521 |
| 40 | 500* | 10,000 | 200,000 | 10* | 1.2 | 60* | 0.625 | — | 3.0 | 2N6427 | — |
| 40 | 1.0 | 20,000 | 50,000 | 150* | — | — | — | 175 | 5.0 | — | 2N6522 |
| 40 | 500* | 20,000 | 200,000 | 10* | 1.2 | 50* | 0.625 | — | 3.0 | 2N6426 | — |
| 40 | 4.0 | 750 | 15,000 | 2.0 | 2.0 | 2.0 | 1.5 | — | — | 2N6037 | 2N6034 |
| 60# | 500* | 1600 | 8,000 | 10* | — | — | 0.5 | — | 6.0 | 2N998 | — |
| 60 | 40* | 2000 | 10,000 | 10* | 1.0 | 10* | 0.5 | 100 | 10 | 2N2723 | — |
| 60 | 4.0 | 750 | — | 1.5 | 2.5 | 1.5 | 40 | — | — | MJE800 | MJE700 |
| 60 | 4.0 | 750 | 15,000 | 2.0 | 2.0 | 2.0 | 1.5 | 25 | — | 2N6038 | 2N6035 |
| 60 | 4.0 | 750 | 18,000 | 2.0 | 2.0 | 2.0 | 50 | 4.0 | — | 2N6294 | 2N6296 |
| 80 | 4.0 | 750 | — | 1.5 | 2.5 | 1.5 | 40 | — | — | MJE802 | MJE702 |
| 80 | 4.0 | 750 | 15,000 | 2.0 | 2.0 | 2.0 | 1.5 | 2.5 | — | 2N6039 | 2N6036 |
| 80 | 4.0 | 750 | 18,000 | 2.0 | 2.0 | 2.0 | 50 | 4.0 | — | 2N6295 | 2N6297 |

| | | | | | |
|--|--|--|---|--|---|
|  Case 20 TO-72 |  Case 22-03 TO-18 |  Case 29-02 TO-92 |  Case 34A |  Case 77-03 |  Case 646 |
| 2N998 2N2723 2N2785 | MM6427 | 2N6425 2N6427 MPS-A12 MPS-A13 MPS-A14 MPS-A65 MPS-A66 MPS-D04 MPS-D64 | 2N6521 2N6522 | 2N6034 2N6035 2N6036 2N6037 2N6038 2N6039 2N6294 2N6295 2N6296 2N6297 MJE700 MJE702 MJE800 MJE802 | MPQ6426 MPQ6427 |

Numbers in italic type denote data sheet that shows design curves.



MICRO-T TRANSISTORS

and DIODES

Micro-T devices combine high performance with extremely small physical size. The type numbers listed below are available from stock, but all other Motorola small-signal transistors may be obtained in Micro-T packages on special order.

TABLE OF CONTENTS

| | Page |
|---|------|
| RF Amplifier Transistors | 4-48 |
| For high-frequency amplifier and switching applications | |
| General Purpose Transistors | 4-48 |
| Most popular discrete amplifiers in Micro-T package | |
| Low Noise Amplifier Transistors | 4-49 |
| Low noise audio and high gain amplifiers | |
| Low Current Switching Transistors | 4-49 |
| High speed switching transistors | |
| Switching Diodes | 4-50 |
| Single and dual diodes with common anode or cathode | |
| Micro-T Field-Effect Transistors | 4-50 |
| J-FET and MOS FET | |

The following Index reflects the devices characterized in this section. To locate the exact page number, see Catalog Index (Page 7-1).

INDEX

| | | |
|----------|---------|---------|
| MMCM930 | MMD6100 | MMT2907 |
| MMCM2221 | MMD6150 | MMT3014 |
| MMCM2222 | MMD7000 | MMT3546 |
| MMCM2369 | MMD7001 | MMT3798 |
| MMCM2484 | MMT70 | MMT3799 |
| MMCM2907 | MMT71 | MMT3823 |
| MMCM3798 | MMT72 | MMT3903 |
| MMCM3799 | MMT75 | MMT3904 |
| MMCM3903 | MMT76 | MMT3905 |
| MMCM3904 | MMT830 | MMT3906 |
| MMCM3905 | MMT2222 | MMT3960 |
| MMCM3906 | MMT2369 | MMT4261 |
| MMD70 | MMT2484 | MMT8015 |
| MMD6050 | MMT2857 | |

RF AMPLIFIER/HIGH SPEED SWITCHING TRANSISTORS

Standard metal packaged RF devices, in Micro-T packages are designed for applications where limited space is critical. This package is particularly attractive from a pre-testing and cost point of view as the RF parameters can be 100% tested for high performance. For complete design data, consult the prime device data sheet. For other RF devices not listed, contact your nearest Motorola sales representative or distributor. Ceramic packages with a cold sealing process will also be available in quantity orders in the future.



Case 28

| Prime Devices | NPN Types | | | PNP Types | |
|--------------------------|-------------------|-------------------|------------------|------------------|------------------|
| | MMT2857 | MMT8015 | MMT3960 | MMT918 | MMT4261 |
| Design Parameters | To 20 V | To 15 V | To 15 V | To 15 V | To 20 V |
| BV_{CEO} | 1.0 to 20 mA | 1.0 to 10 mA | 1.0 to 30 mA | 3.0 mA | 10 mA |
| Operating h_{FE} Range | 1400 MHz @ 5.0 mA | 2000 MHz @ 6.0 mA | 1600 MHz @ 10 mA | 600 MHz @ 4.0 mA | 1000 MHz @ 10 mA |
| f_T (Typ) | 4.0 dB @ 1.5 mA | 3.5 dB @ 1.0 mA | — | 6.0 dB @ 1.0 mA | — |
| NF (Typ) | 15 dB @ 450 MHz | 7.0 dB @ 1.0 GHz | — | 15 dB @ 200 MHz | — |
| G_{pe} (Typ) | — | — | 3.0 ns @ 10 mA | — | — |
| t_{on} (Typ) | — | — | — | — | — |

MMT4049 PNP RF Amplifier — to be introduced.

GENERAL-PURPOSE AND SWITCHING TRANSISTORS

For general-purpose applications and for designs requiring fast switching, the Micro-T packaged transistors are available in either economy plastic or hermetically sealed ceramic. Complete designer data sheets are available for prime devices; equivalent data sheets may be obtained when the same die is used in other 2N — standard devices. For devices not listed, contact your nearest Motorola representative or distributor.

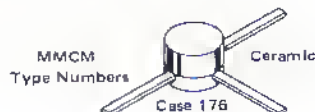


MMT

Type Numbers

Plastic

Case 28



MMCM

Type Numbers

Ceramic

Case 176

| Prime Devices | NPN Types | | PNP Types | |
|--------------------------------|-----------------------|---|-----------------------|---|
| | MMT2222 MMCM2222 | MMT3904 MMCM3904 | MMT2907 MMCM2807 | MMT3906 MMCM3906 |
| Design Parameters | To 60 V | To 40 V | To 60 V | To 40 V |
| BV_{CEO} | 100 μ A to 500 mA | 100 μ A to 100 mA | 100 μ A to 500 mA | 100 μ A to 100 mA |
| Operating h_{FE} Range | 300 MHz @ 20 mA | 300 MHz @ 10 mA | 350 MHz @ 50 mA | 350 MHz @ 10 mA |
| f_T (Typ) | 25 ns | 40 ns | 30 ns | 45 ns |
| t_{on} (Typ) | @ 150 mA | @ 10 mA | @ 150 mA | @ 10 mA |
| t_{off} (Typ) | 250 ns | 140 ns | 100 ns | 160 ns |
| Derivatives from Prime Devices | Ceramic Package | Plastic Package | | Plastic Package |
| | MMCM2221 | MMT3903 MMT75 Ceramic Package MMCM3903 | | MMT3905 MMT75 Ceramic Package MMCM3905 |

LOW NOISE/HIGH GAIN AMPLIFIER TRANSISTORS

Two types of specialty transistors complement Motorola's micro-transistor amplifier selection. The combination of high-gain and low-noise have made these standards popular for many years. The Micro-T package coupled with performance permits space premium designs to become a reality. Other high voltage and Darlington transistors are also available as specials.



| | NPN Types | | PNP Types | |
|---|--|------------------------------------|--|-------------------------------------|
| Prime Devices | MMT2484 MMCM2484 | | MMT3799 MMCM3799 | |
| Design Parameters BV _{CEO} Operating h _{FE} Range f _T (Typ) NF (Typ) | To 60 V 100 μ A to 10 mA 90 MHz @ 500 μ A 2.0 dB @ 10 μ A | | To 60 V 10 μ A to 10 mA 140 MHz @ 1.0 mA 1.5 dB @ 100 μ A | |
| Derivatives from Prime Devices | Ceramic Package MMCM930 | Plastic Package MMT930 MMT70 | Ceramic Package MMCM3798 | Plastic Package MMT3798 MMT71 |

LOW CURRENT SWITCHING TRANSISTORS

To complement the Micro-T amplifiers, these high speed switching transistors can be used in circuits where space limitations are critical. For design data, consult prime device data sheet or the 2N JEDEC equivalent. For devices not listed, consult your nearest Motorola sales representative or distributor.



| | NPN Types | | PNP Types |
|--|--|--|---|
| Prime Devices | MMT2369 MMCM2369 | MMT3014 | MMT3546 |
| Design Parameters BV _{CEO} Operating h _{FE} Range f _T (Typ) t _{on} (Typ) t _{off} (Typ) | To 15 V 10 mA to 100 mA 650 MHz @ 10 mA 2.0 ns @ 10 mA 15 ns | To 20 V 10 mA to 100 mA 400 MHz @ 30 mA 12 ns @ 300 mA 13 ns | To 12 V 10 mA to 100 mA 850 MHz @ 10 mA 15 ns @ 50 mA 25 ns |
| Derivatives from Prime Devices | | Plastic Package MMT72 | |

SWITCHING DIODES

The Micro-T product line includes single and double diodes for voltage doubling or bias control functions. Zener diodes are also available as specials. For lead times and availability, contact your nearest distributor or Motorola's sales representative.



| | Single | Common Cathode | Common Anode | Series |
|--------------------------------|----------------|----------------|----------------|----------------|
| Prime Devices | MMD6050 | MMD6100 | MMD6150 | MMD7000 |
| Design Parameters: | | | | |
| V_{BR} | To 100 V | To 100 V | To 100 V | To 100 V |
| I_R (Typ) | 10 mA | 10 mA | 10 mA | 10 mA |
| V_F (Typ) | 0.6 V @ 1.0 mA | 0.6 V @ 1.0 mA | 0.6 V @ 1.0 mA | 0.6 V @ 1.0 mA |
| t_{rr} (Typ) | 10 ns | 20 ns | 20 ns | 20 ns |
| Derivatives from Prime Devices | MMO70 | | | MMO7001 |

MICRO-T FIELD-EFFECT TRANSISTORS

Technologies other than bipolar transistors are available in the Micro-T package. One example is the popular J-FET. Also available are other J-FET and MOSFET devices requiring up to four leads and having a chip size less than 25 mils per side. For lead time and availability, contact your nearest Motorola sales representative.



| | N-Channel J-FET |
|--------------------|---|
| Prime Device | MMT3823 |
| Design Parameters: | |
| BV_{GS} | To 35 V |
| I_{QSS} (surge) | 5.0 mA to 20 mA |
| C_{iss} (Typ) | 4.0 pF |
| NF (Typ) | 2.0 dB @ 100 MHz, $R_S = 1000 \text{ Ohms}$ |

Note: Other FETs are available as specials. Standard FET devices to be introduced.



RF TRANSISTORS

and MODULES

This selection guide contains the preferred registered and non-registered RF parts available. From more than 500 total individual available devices, Motorola has selected 17 transistor/module chains from 1.5 to 600 W (PEP) output. All devices are designed, tested and optimized for frequency ranges from 2 to 900 MHz. These devices are designed for your advanced RF engineering concepts.

TABLE OF CONTENTS

| | Page |
|--|------|
| High Frequency, Low-Voltage Amplifier Transistors/Modules cover the spectrum from 2 to 947 MHz (7.5 to 13.6 Volts) | 4-53 |
| High Frequency, High Voltage, Power Amplifier Transistors cover the spectrum from 2 to 400 MHz (28 to 50 Volts) | 4-57 |
| Power Varactor Multipliers. | 4-59 |
| 15 Watts at 450 MHz to 2.0 Watts at 6 GHz | |
| UHF and Microwave Oscillators | 4-59 |
| 400 MHz to 2.0 GHz | |
| Low-Noise Transistors | 4-59 |
| Noise Figure versus Frequency | |
| General-Purpose Transistors | 4-60 |
| f_T versus I_C | |
| CATV, MATV, and Class A Linear Transistors | 4-60 |
| f_T and Noise Figure | |
| Hybrid Amplifier Modules | 4-61 |
| CATV Hybrid Modules cover the spectrum from 40 to 512 MHz | |

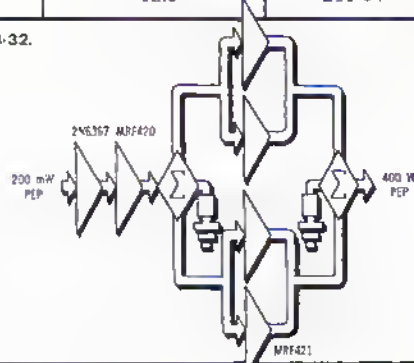
The following Index reflects the devices characterized in this section. To locate the exact page number, see Catalog Index (Page 7-1).


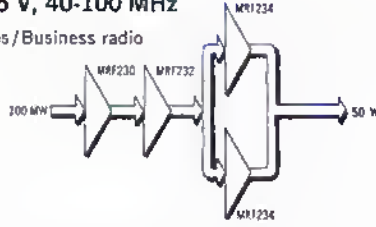
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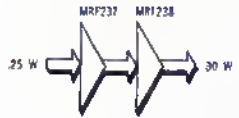
| Device Type | Package | Device Type | Package | Device Type | Package | Device Type | Package |
|-------------|---------|-------------|---------|-------------|---------|-------------|---------|
| 1N4387 | 44 | 2N5841 | TO-72 | MRF208 | 145A-07 | MRF453A | 145A-04 |
| 1N4388 | 44 | 2N5847 | 145A-07 | MRF209 | 145A-07 | MRF454 | 211-10 |
| 1N5149 | 47 | 2N5848 | 145A-07 | MRF212 | 145A-07 | MRF454A | 145A-04 |
| 1N5150 | 47 | 2N5849 | 145A-08 | MRF215 | 278-06 | MRF501 | TO-72 |
| 1N5150A | 47 | 2N5941 | 211-07 | MRF216 | 278-06 | MRF502 | TO-72 |
| 1N5153 | 47 | 2N5942 | 211-10 | MRF221 | 211-07 | MRF509 | 207A-01 |
| 1N5153A | 47 | 2N5943 | TO-39 | MRF222 | 211-07 | MRF611 | 144D-05 |
| 1N5155 | 46 | 2N5944 | 244-04 | MRF223 | 211-07 | MRF515 | TO-39 |
| 1N5155A | 48 | 2N5945 | 244-04 | MRF224 | 211-07 | MRF517 | TO-39 |
| 2N2857 | TO-72 | 2N5946 | 244-04 | MRF225 | TO-39 | MRF519 | TO-39 |
| 2N3553 | TO-39 | 2N6080 | 145A-07 | MRF228 | 145A-07 | MRF531 | TO-39 |
| 2N3632 | TO-60 | 2N6081 | 145A-07 | MRF227 | TO-39 | MRF532 | TO-39 |
| 2N3839 | TO-72 | 2N6082 | 145A-07 | MRF230 | TO-39 | MRF601 | 297-01 |
| 2N3948 | TO-39 | 2N6083 | 145A-07 | MRF231 | 145A-07 | MRF602 | 297-01 |
| 2N3960 | TO-18 | 2N6084 | 145A-07 | MRF232 | 145A-07 | MRF604 | TO-46 |
| 2N4073 | TO-39 | 2N6166 | 211-10 | MRF233 | 145A-07 | MRF607 | TO-39 |
| 2N4427 | TO-39 | 2N6255 | TO-39 | MRF234 | 145A-07 | MRF618 | 278-06 |
| 2N4428 | TO-39 | 2N6258 | 249-05 | MRF235 | 145A-07 | MRF626 | 305-01 |
| 2N4957 | TO-72 | 2N6304 | TO-72 | MRF237 | TO-39 | MRF627 | 305A-01 |
| 2N4958 | TO-72 | 2N6305 | TO-72 | MRF238 | 145A-07 | MRF628 | 249-05 |
| 2N4959 | TO-72 | 2N8367 | 211-07 | MRF243 | 278-06 | MRF629 | TO-39 |
| 2N5031 | TO-72 | 2N8368 | 211-10 | MRF244 | 278-06 | MRF644 | 278-06 |
| 2N5032 | TO-72 | 2N6370 | 211-07 | MRF245 | 278-06 | MRF646 | 278-06 |
| 2N5070 | TO-60 | 8FR90 | 302A-01 | MRF304 | 278-06 | MRF816 | 249-05 |
| 2N5108 | TO-39 | 8FR91 | 302A-01 | MRF305 | 278-06 | MRF817 | 244-04 |
| 2N5109 | TO-39 | 8FR96 | 302A-01 | MRF306 | 278-06 | MRF818 | 244-04 |
| 2N5160 | TO-39 | 8FY90 | TO-72 | MRF313 | 305-01 | MRF823 | 278-05 |
| 2N5179 | TO-72 | 8FX89 | TO-72 | MRF313A | 305A-01 | MRF824 | 278-05 |
| 2N5583 | TO-39 | MHW401 | 301-01 | MRF401 | 145A-01 | MRF825 | 278-05 |
| 2N5589 | 144B-04 | MHW559 | 270-02 | MRF402 | TO-39 | MRF835 | 278-05 |
| 2N5590 | 145A-07 | MHW582 | 270-02 | MRF406 | 211-07 | MRF901 | 302-01 |
| 2N5591 | 145A-07 | MHW570 | 270A-01 | MRF420 | 211-10 | MRF904 | TO-72 |
| 2N5635 | 144B-04 | MHW572 | 270A-01 | MRF421 | 211-08 | MRF961 | 302-01 |
| 2N5636 | 144B-04 | MHW580 | 714 | MRF422 | 211-08 | MRF517A | 244-04 |
| 2N5637 | 145A-07 | MHW601 | 297-01 | MRF425 | 145A-08 | MRF517S | 244-04 |
| 2N5641 | 144B-04 | MHW602 | 297-01 | MRF427 | 145A-08 | MRF5176 | 244-04 |
| 2N5642 | 145A-07 | MHW709 | 700-01 | MRF428 | 307-01 | MRF5177 | 215-01 |
| 2N5643 | 145A-07 | MHW710 | 700-01 | MRF432 | 211-07 | MRF5177A | 145A-07 |
| 2N5644 | 145A-07 | MHW710 | 700-01 | MRF433 | 211-07 | MRF8004 | TO-39 |
| 2N5829 | TO-72 | MM4019 | TO-39 | MRF449 | 211-07 | MV1805C | 47 |
| 2N5835 | TO-72 | MM4049 | TO-72 | MRF449A | 145A-07 | MV1805J | 44 |
| 2N5836 | TO-46 | MM8001 | TO-39 | MRF450 | 211-07 | MV1807J1 | 44 |
| 2N5837 | TO-46 | MM8009 | TO-39 | MRF450A | 145A-07 | MV1809C1 | 47 |
| | | MRF207 | TO-39 | MRF453 | 211-10 | | |

High Frequency, Low Voltage Amplifier Transistors/ Modules

The transistors listed in this table are specified for operation in RF Power amplifiers and are listed by specific application at a given test frequency. Arrangement within each application group is in the order of increasing output power. Modulation type is given in each application heading.

| Device Type | P _{out} Output Power Watts | G _{re} Power Gain dB Min | V _{cc} Supply Voltage Volts | Package |
|--|---|---|--|---------|
| 2-30 MHz, SSB TRANSISTORS | | | | |
| 2N6367 | 9.0 PEP | 14 | 12.5 | 211-07 |
| MRF432* | 12.5 PEP | 20 | 12.5 | 211-07 |
| MRF433* | 12.5 PEP | 20 | 12.5 | 211-07 |
| MRF406 | 20 PEP | 12 | 12.5 | 211-07 |
| MRF425 | 30 PEP | 12 | 12.5 | 145A-08 |
| 2N6368 | 40 PEP | 10 | 12.5 | 211-10 |
| MRF420 | 75 PEP | 10 | 12.5 | 211-10 |
| MRF421 | 100 PEP | 10 | 12.5 | 211-04 |
| <p>*PNP/NPN Complements for Complementary Symmetry Driver, See EB-32. For Matched Pairs Order MK433.</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> <p>Chain 1 — 12.5 V, 2-30 MHz</p> <p>Off-road vehicles/Oil tankers / Fishing fleets</p> </div>  </div> | | | | |
| 14-30 MHz, CB/AMATEUR TRANSISTORS | | | | |
| MRF8004 | 3.5 | 10 | 12.5 | TO-39 |
| MRF449 | 30 | 10 | 13.6 | 211-07 |
| MRF449A | 30 | 10 | 13.6 | 145A-07 |
| MRF450 | 50 | 11 | 13.6 | 211-07 |
| MRF450A | 50 | 11 | 13.6 | 145A-07 |
| MRF453 | 60 | 11 | 13.6 | 211-10 |
| MRF453A | 60 | 11 | 13.6 | 145A-04 |
| MRF454 | 80 | 11 | 13.6 | 211-10 |
| MRF454A | 80 | 11 | 13.6 | 145-04 |
| 27-50 MHz, LOW-BAND FM TRANSISTORS | | | | |
| MRF402 | 1.0 | 10 | 12.5 | TO-39 |
| 2N5847 | 8.0 | 10 | 12.5 | 145A-07 |
| 2N5848 | 20 | 8.0 | 12.5 | 145A-07 |
| 2N5849 | 40 | 7.5 | 12.5 | 145A-08 |

| Device Type | P_{out} Output Power Watts | G_{FE} Power Gain dB Min | V_{CC} Supply Voltage Volts | Package |
|---|------------------------------------|----------------------------------|-------------------------------------|---------|
| 40-100 MHz, MIDBAND FM TRANSISTORS | | | | |
| MRF230 | 1.5 | 10 | 12.5 | TO-39 |
| MRF231 | 3.5 | 10 | 12.5 | 145A-07 |
| MRF232 | 7.5 | 9.0 | 12.5 | 145A-07 |
| MRF233 | 15 | 9.5 | 12.5 | 145A-07 |
| MRF234 | 25 | 10 | 12.5 | 145A-07 |
| MRF235 | 50 | 8.0 | 12.5 | 145A-07 |
| <div> <div> Chain 2 — 12.5 V, 40-100 MHz European taxis/Off-shore oil rigs  </div> <div> Chain 3 — 12.5 V, 40-100 MHz European buses/Business radio  </div> </div> | | | | |

| | | | | |
|---|-----------|-----------|--------------|------------------|
| 156-162 MHz, VHF MARINE RADIO FM TRANSISTORS | | | | |
| MRF237** MRF238 | 4.0 30 | 12 9.0 | 12.5 12.5 | TO-39 145A-07 |
| <div> Chain 4 — 13.6 V, 160 MHz Marine radio/Pleasure craft/Fishing boats/2 meter "ham band"  </div> | | | | |
| **Grounded emitter TO-39 package. See EB-29 | | | | |

| | | | | |
|--|------|------|------|---------|
| 130-175 MHz, HIGH BAND/VHF FM TRANSISTORS | | | | |
| MRF604 | 1.0 | 10 | 12.5 | TO-46 |
| 2N4427 | 1.0 | 10 | 12 | TO-39 |
| MRF607 | 1.75 | 12.5 | 12.5 | TO-39 |
| 2N6255 | 3.0 | 7.8 | 12.5 | TO-39 |
| 2N5589 | 3.0 | 8.2 | 13.6 | 144B-06 |
| MRF237** | 4.0 | 12 | 12.5 | TO-39 |
| 2N6080 | 4.0 | 12 | 12.5 | 145A-07 |
| 2N5590 | 10 | 5.2 | 13.6 | 145A-07 |
| MRF212 | 10 | 9.0 | 12.5 | 145A-07 |

**Grounded emitter TO-39 package. See EB-29

RF TRANSISTORS AND MODULES (continued)

| Device Type | P _{out} Output Power Watts | G _{av} Power Gain dB Min | V _{cc} Supply Voltage Volts | Package |
|--|---|---|--|---------|
| 130-175 MHz, HIGH BAND/VHF FM TRANSISTORS | | | | |
| 2N6081 | 15 | 6.3 | 12.5 | 145A-07 |
| MRF221 | 15 | 6.3 | 12.5 | 211-07 |
| MRF215* | 20 | 8.2 | 12.5 | 278-06 |
| 2N5591 | 25 | 4.4 | 13.6 | 145A-07 |
| 2N6082 | 25 | 6.2 | 12.5 | 145A-07 |
| MRF222 | 25 | 6.2 | 12.5 | 211-07 |
| 2N6083 | 30 | 5.7 | 12.5 | 145A-07 |
| MRF223 | 30 | 5.7 | 12.5 | 211-07 |
| 2N6084 | 40 | 4.5 | 12.5 | 145A-07 |
| MRF224 | 40 | 4.5 | 12.5 | 211-07 |
| MRF216* | 40 | 6.7 | 12.5 | 278-06 |
| MRF243* | 60 | 7.0 | 12.5 | 278-06 |
| MRF244* | 70 | 6.6 | 12.5 | 278-06 |
| MRF245* | 80 | 6.4 | 12.5 | 278-06 |

* Controlled "Q" transistor. See EB-19.

| | | | | |
|--|----|----|------|--------|
| 146-175 MHz, HIGH BAND/VHF FM MODULES | | | | |
| MHW601 | 13 | 21 | 12.5 | 297-01 |
| MHW602 | 20 | 21 | 12.5 | 297-01 |

See EB-23 for applications information.

**Chain 5 — 12.5 V,
175 MHz**

150 mW → MHW602 → MRF293 → 110 W

Construction vehicles/
Oil fields/
Business band

**Chain 6 — 12.5 V,
175 MHz**

25 W → MRF237 → 2N6082 → MRF245 → 80 W

Business band/Truck dispatch

**Chain 7 — 12.5 V,
175 MHz**

15 W → MRF237 → MRF238 → MRF295 → 160 W

Police/Fire/Ambulance

| | | | | |
|--|-----|------|------|---------|
| 220 MHz, CITIZENS BAND FM TRANSISTORS | | | | |
| MRF207 | 1.0 | 8.2 | 12.5 | TO-39 |
| MRF225 | 1.5 | 9.0 | 12.5 | TO-39 |
| MRF227* | 3.0 | 13.5 | 12.5 | TO-39 |
| MRF208 | 10 | 10 | 12.5 | 145A-07 |
| MRF226 | 13 | 9.0 | 12.5 | 145A-07 |
| MRF209 | 25 | 4.4 | 12.5 | 145A-07 |

Grounded emitter: TO-39 package. See EB-29.

Chain 8 — 12.5 V, 225 MHz

200 mW → MRF225 → MRF226 → 13 W

1 1/4 meter "ham band"/225 MHz class E/Communicator class

| | | | | |
|--|------|-----|------|---------|
| 407-512 MHz, UHF FM TRANSISTORS | | | | |
| 2N6256 | 0.5 | 10 | 12.5 | 249-05 |
| MRF626 | 0.5 | 10 | 12.5 | 305-01 |
| MRF627 | 0.5 | 10 | 12.5 | 305A-01 |
| MRF628 | 0.5 | 10 | 12.5 | 249-05 |
| MRF515 | 0.75 | 8.0 | 12.5 | TO-39 |
| 2N3948 | 1.0 | 6.0 | 13.6 | TO-39 |
| 2N5644 | 1.0 | 7.0 | 12.5 | 145A-07 |
| MRF629** | 2.0 | 8.0 | 12.5 | TO-39 |
| 2N5944 | 2.0 | 9.0 | 12.5 | 244-04 |
| 2N5945 | 4.0 | 8.0 | 12.5 | 244-04 |
| 2N5946 | 10 | 6.0 | 12.5 | 244-04 |
| MRF618* | 15 | 6.0 | 12.5 | 278-06 |
| MRF644* | 25 | 6.2 | 12.5 | 278-06 |
| MRF646* | 40 | 4.9 | 12.5 | 278-06 |

* Controlled "Q" transistor. See EB-19.

** Grounded emitter TO-39 package.

AMPLIFIER MODULES

| MODULE | P_{out} Output Power Watts | f MHz | G_{re} Power Gain dB Min | V_{DC} Supply Voltage | Package |
|------------------------------------|------------------------------------|------------|----------------------------------|----------------------------|---------|
| 407-512 MHz, UHF FM MODULES | | | | | |
| MHW401-1 | 1.5 | 400-440 | 15 | 7.5 | 301-Q1 |
| MHW401-2 | 1.5 | 440-470 | 15 | 7.5 | 301-Q1 |
| MHW401-3 | 1.5 | 470-512 | 15 | 7.5 | 301-Q1 |
| MHW709-1 | 7.5 | 400-440 | 18.8 | 12.5 | 700-Q1 |
| MHW709-2 | 7.5 | 440-470 | 18.8 | 12.5 | 700-Q1 |
| MHW709-3 | 7.5 | 470-512 | 18.8 | 12.5 | 700-Q1 |
| MHW710-1 | 13 | 400-440 | 19.4 | 12.5 | 700-Q1 |
| MHW710-2 | 13 | 440-470 | 19.4 | 12.5 | 700-Q1 |
| MHW710-3 | 13 | 470-512 | 19.4 | 12.5 | 700-Q1 |

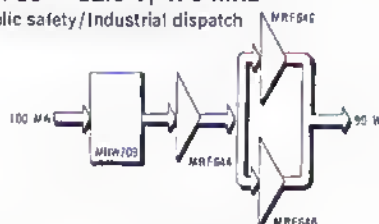
See EB 8 for applications information

Chain 9 — 12.5 V, 512 MHz

Agricultural communications/Base stations/Repeaters


Chain 10 — 12.5 V, 470 MHz

Public safety/Industrial dispatch



| Device Type | P_{out} Output Power Watts | G_{re} Power Gain dB Min | V_{CC} Supply Voltage Volts | Package |
|--|------------------------------------|----------------------------------|-------------------------------------|---------|
| 806-947 MHz, UHF FM TRANSISTORS | | | | |
| MRF816 | 0.75 | 10 | 12.5 | 249-05 |
| MRF817 | 2.5 | 6.2 | 13.6 | 244-04 |
| MRF823* | 5.0 | 8.0 | 12.5 | 278-05 |
| MRF818 | 8.0 | 5.05 | 13.6 | 244-04 |
| MRF824* | 12 | 4.8 | 12.5 | 278-05 |
| MRF835** | 15 | 7 (G_{re}) | 12.5 | 278-05 |
| MRF825* | 25 | 4.5 | 12.5 | 278-05 |

*Controlled "Q" transistor. See EB-19 **Gold metallization, controlled "Q" transistor. See EB-26, EB-19


Chain 12 — 12.5 V, 870 MHz
Base station/Industrial dispatch

Chain 11 — 12.5 V, 850 MHz
Cellular radio telephone

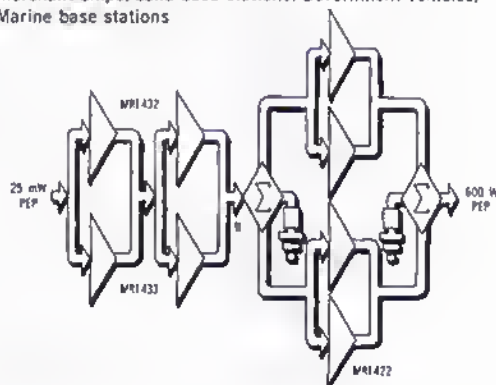
High Frequency, High Voltage, Power Amplifier Transistors

The transistors listed in this table are specified for operation in RF Power amplifiers and are listed by specific application at a given test frequency. Arrangement within each application group is in the order of increasing output power. Modulation type is given in each application heading.

| Device Type | P_{out} Output Power Watts | G_{re} Power Gain dB Min | V_{cc} Supply Voltage Volts | Package |
|----------------------------------|------------------------------------|----------------------------------|-------------------------------------|---------|
| 2-30 MHz, SS8 TRANSISTORS | | | | |
| 2N6370 | 10 PEP | 12 | 28 | 211-07 |
| MRF432 | 12.5 PEP | 20 | 12.5 | 211-07 |
| MRF433 | 12.5 PEP | 20 | 12.5 | 211-07 |
| 2N5070 | 25 PEP | 13 | 28 | TO-60 |
| MRF401 | 25 PEP | 13 | 28 | 145A-07 |
| MRF427 | 25 PEP | 12 | 50 | 145A-08 |
| 2N5941 | 40 PEP | 13 | 28 | 211-07 |
| 2N5942 | 80 PEP | 10 | 28 | 211-04 |
| MRF422 | 150 PEP | 10 | 28 | 211-04 |
| MRF428 | 150 PEP | 13 | 50 | 307-01 |

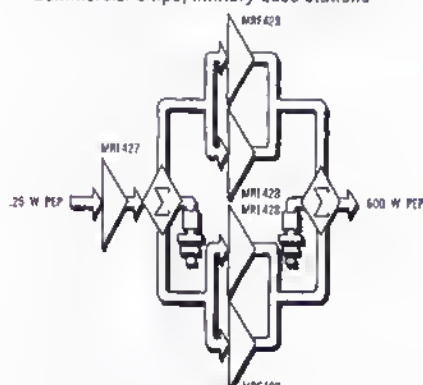
Chain 13 — 28 V, 2-30 MHz

Merchant ships/Land-base stations/Government vehicles/
Marine base stations



Chain 14 — 50 V, 2-30 MHz

Commercial ships/Military base stations

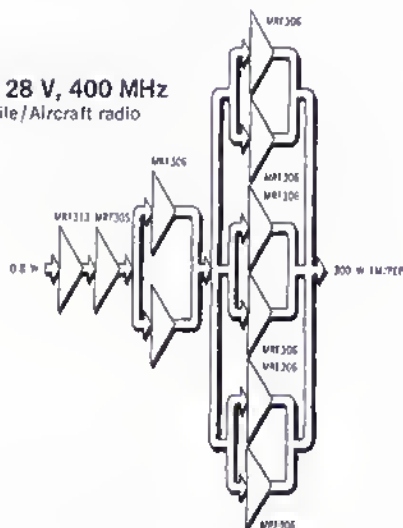


RF TRANSISTORS AND MODULES (continued)

| Device Type | P _{out} Output Power Watts | G _{RF} Power Gain dB Min | V _{CC} Supply Voltage Volts | Package |
|--|---|---|--|---------|
| 106-175 MHz, VHF AM TRANSISTORS | | | | |
| 2N3866 | 1.0 | 10 | 28 | TO-39 |
| 2N3553 | 2.5 | 10 | 28 | TO-39 |
| 2N5641 | 7.0 | 8.4 | 28 | 144B-04 |
| 2N5642 | 20 | 8.2 | 28 | 145A-07 |
| 2N5643 | 40 | 7.6 | 28 | 145A-07 |
| 2N6166 | 100 | 6.0 | 28 | 211-10 |
| 225-400 MHz, UHF AM TRANSISTORS | | | | |
| MRF509 | 1.0 | 10 | 28 | 207A-01 |
| 2N3866 | 1.0 | 10 | 28 | TO-39 |
| MRF313 | 1.0 | 16 (Typ) | 28 | 305-01 |
| MRF313A | 1.0 | 16 (Typ) | 28 | 305A-01 |
| MRF5174 | 2.0 | 12 | 28 | 244-04 |
| 2N5635 | 2.5 | 6.2 | 28 | 144B-04 |
| MRF5175 | 5.0 | 11 | 28 | 244-04 |
| 2N5636 | 7.5 | 5.7 | 28 | 144B-04 |
| MRF304* | 10 | 9.0 | 28 | 278-06 |
| MRF5176 | 15 | 10 | 28 | 244-04 |
| 2N5637 | 20 | 4.6 | 28 | 145A-07 |
| MRF5177 | 30 | 6.0 | 28 | 215-01 |
| MRF5177A | 30 | 6.0 | 28 | 145A-07 |
| MRF305* | 30 | 8.0 | 28 | 278-06 |
| MRF306** | 60 | 8.0 | 28 | 278-06 |

* Controlled "Q" transistor. See EB-19 ** Gold metallization, double matched controlled "Q" transistor. See EB-26, EB-19

Chain 15 — 28 V, 400 MHz
Fixed/Mobile/Aircraft radio



Chain 16 — 28 V, 400 MHz
Aircraft radio



Power Varactor Multipliers

Motorola's line of step-recovery multipliers represents a selection of frequency doublers and triplers. Output capabilities range from 15 watts at 450 MHz to 2 watts at 6 GHz. The table is arranged in order of decreasing output frequency.

| Device Type | f_{out} GHz | P_{out} Min Watts | f_{in} GHz | P_{in} Watts | Package |
|-------------|------------------|------------------------|-----------------|-------------------|---------|
| 1N5155A | 6.0 | 2.0 | 2.0 | 5.0 | 46 |
| 1N5155 | 6.0 | 2.0 | 2.0 | 5.0 | 46 |
| MV1809C1 | 2.0 | 14.5 | 1.0 | 25 | 47 |
| 1N5153 | 2.0 | 6.0 | 1.0 | 12 | 47 |
| 1N5153A | 2.0 | 7.2 | 1.0 | 12 | 47 |
| 1N5150A | 1.0 | 25 | 0.5 | 37 | 47 |
| MV1807J1 | 1.0 | 25 | 0.5 | 37 | 44 |
| 1N5150 | 1.0 | 24 | 0.5 | 37 | 47 |
| 1N5149 | 1.0 | 11 | 0.5 | 20 | 47 |
| 1N4388 | 1.0 | 11 | 0.5 | 20 | 44 |
| MV1805C | 0.75 | 26 | 0.25 | 40 | 47 |
| MV1805J | 0.75 | 26 | 0.25 | 40 | 44 |
| 1N4387 | 0.45 | 15 | 0.15 | 30 | 44 |

UHF and Microwave Oscillators

The transistors listed below are for UHF and microwave oscillator applications as initial signal sources or as output stages of limited range transmitters. Devices are listed in order of increasing test frequency.

| Device Type | Test Conditions | | P_{out} mW Typ* Min | f_r MHz Typ* Min | Package |
|-------------|-----------------|-------------------|-----------------------------|--------------------------|---------|
| | f MHz | V_{CC} Volts | | | |
| 2N3866 | 400 | 15 | 1000 | 500 | TO-39 |
| 2N5179 | 500 | 10 | 20 | 900 | TO-72 |
| 2N2857 | 500 | 10 | 30 | 1000 | TO-72 |
| 2N3839 | 500 | 6.0 | 30 | 1000 | TO-72 |
| MM8009 | 1680 | 20 | 200 | 1000 | TO-39 |
| 2N5108 | 1680 | 20 | 300 | 1200 | TO-39 |
| MRF905 | 1680 | 20 | 500* | 2200* | TO-46 |

Low-Noise Transistors

The low-noise devices listed are produced with carefully controlled r_{be} and f_T to optimize device noise performance. Devices listed in the matrix are classified according to noise figure performance versus frequency.

| NF dB | FREQUENCY MHz | | | | | | Polarity |
|----------|------------------|------------------|------------------|------------------|------------------|--------|------------|
| | 60 | 100 | 200 | 450 | 1000 | 2000 | |
| 1.5 | 2N5829 2N5031 | 2N5829 2N5031 | MRF904 | | | | PNP NPN |
| 2.0 | 2N4957 2N5032 | 2N4957 2N5032 | 2N5829 2N5031 | MRF904 | MRF901 | | PNP NPN |
| 2.5 | 2N4958 2N5032 | 2N4958 2N5032 | 2N4957 2N5032 | 2N5829 2N5031 | MRF901 | | PNP NPN |
| 3.0 | 2N4959 2N2857 | 2N4959 2N2857 | 2N4958 2N5032 | 2N4957 2N5032 | 2N5829 MRF901 | MRF901 | PNP NPN |
| 3.5 | 2N4959 2N5179 | 2N4959 2N5179 | 2N4959 2N2857 | 2N4958 2N5032 | 2N4957 2N5031 | | PNP NPN |
| 4.0 | 2N4959 2N5179 | 2N4959 2N5179 | 2N4959 2N5179 | 2N4959 2N2857 | 2N4958 2N5031 | | PNP NPN |
| 4.5 | 2N4959 2N5179 | 2N4959 2N5179 | 2N4959 2N5179 | 2N4959 2N2857 | 2N4959 2N5032 | | PNP NPN |

General-Purpose Amplifier Transistors

The behavior of f_t as a function of I_c is critical in most Class A amplifier applications. The devices listed in the matrix form below are classified according to f_t versus I_c .

| f_t GHz Min | COLLECTOR CURRENT mA | | | | | | | Polarity |
|---------------------|----------------------|------------------|------------------|---------------------|---------------------|------------------|------------------|------------|
| | 2.0 | 5.0 | 10 | 20 | 50 | 100 | 200 | |
| 5.0 | | | | MRF911 | MRF691 | | | NPN |
| 4.5 | | | | MM4049 MRF901 | | | | PNP NPN |
| 4.0 | | | MM4049 MRF901 | MM4049 MRF901 | MRF961 | | | PNP NPN |
| 3.5 | | MM4049 MRF901 | MM4049 MRF901 | MM4049 MRF901 | MRF961 | | | PNP NPN |
| 2.5 | MRF901 | MRF901 | 2N5835 | 2N5835 | 2N5836 | | | PNP NPN |
| 2.0 | | 2N5031 | 2N5841 | 2N5841 | 2N5836 | 2N5837 | 2N5837 | PNP NPN |
| 1.5 | 2N5031 | 2N4957 2N3960 | 2N6304 | 2N6304 | 2N5583 2N5943 | 2N5583 2N5109 | 2N5837 | PNP NPN |
| 1.2 | 2N4957 | 2N4959 2N2857 | 2N6305 | 2N6305 | 2N5583 2N5943 | 2N5583 2N5109 | 2N5583 | PNP NPN |
| 1.0 | 2N5179 | 2N5179 | 2N2857 | 2N5583 2N5943 | 2N5160 MM8001 | 2N5160 2N5108 | 2N5583 | PNP NPN |
| 0.8 | MRF502 | MRF502 | MRF502 | 2N5160 2N3866 | 2N5160 2N3866 | 2N5160 2N4428 | 2N5583 | PNP NPN |
| 0.6 | MRF501 | MRF501 | MRF501 | 2N3866 | 2N4073 | MM4019 2N3553 | MM4019 2N3553 | PNP NPN |
| 0.5 | | | | MRF532* MRF531** | MRF532* MRF531** | | | PNP NPN |

6V_{CE} = 80 Vdc **6V_{CE} = 100 Vdc

CATV, MATV, and Class A Linear Transistors

The devices listed below are excellent for Class A linear CATV/MATV applications. The new MRF511 is gaining wide industry acceptance. The devices are listed according to increasing Current-Gain (f_t). More information concerning the device for your specific linear design needs can be obtained through your local Motorola Sales Office or Motorola distributor.

| Device Type | Nominal Test Conditions V_{CE}/I_c Volts/mA | f_t MHz Min Typ* | Noise Figure | | Distortion Specifications | | | | Package |
|-------------|---|-----------------------------|----------------|--------------|---------------------------|---------------------|--------------------------|-------------------------|---------|
| | | | Max or Typ* | Freq. MHz | 2nd Order IMD | 3rd Order IMD | 12 ch. Cross- Mod. | Output Level dBmV | |
| MRF501 | 6/2.5 | 600 | 4.5°/200 | | | | | | TO72 |
| MRF502 | 6/2.5 | 800 | 4.0°/200 | | | | | | TO72 |
| 2N5179 | 6/1.5-2 | 900 | 4.5°/200 | | | | | | TO72 |
| BFY90 | 5/2 | 1000 | 5.0°/500 | | | | | | TO72 |
| 2N6305 | 5/2-10 | 1200 | 5.5°/450 | | | | | | TO72 |
| BFX89 | — | 1200 | 6.5°/500 | | | | | | TO72 |
| 2N5109 | 15/10-50 | 1200 | 3.0°/200 | | | | | | TO39 |
| 2N5943 | 15/30-50 | 1200 | 6.8°/200 | | -50 | | -42 | +50 | TO39 |
| 2N6304 | 5/2-10 | 1400 | 4.5°/450 | | | | | | TO72 |
| MRF511 | 20/50-80 | 1500 | 7.3°/200 | | -50 | -65 | -57 | +50 | 144D-04 |
| MRF517 | 15/25-60 | 2200 | 7.5°/300 | | -60 | -72 | -57 | +45 | TO39 |
| MRF519 | 20/50-80 | 2200 | 8.0°/300 | | -50 | -68 | -57 | +50 | TO39(1) |
| BFR90 | 10/14 | 5000° | 2.4°/500 | | | | | | 302 |
| BFR91 | 5/35 | 5000° | 1.9°/500 | | | | | | 302 |
| BFR96 | 10/50 | 5000° | 3.3°/500 | | | | | | 302 |

(1) Grounded Emitter TO39 (Case 79-05)

Hybrid Amplifier Modules

The Hybrid Modules listed are specified for amplifier applications in CATV distribution equipment but are applicable wherever broadband (HF/VHF) low distortion, low-noise amplification is required. These devices can also be used for Broadband Medium Power (0.5 W) Driver Amplifiers.

CATV HYBRID MODULES

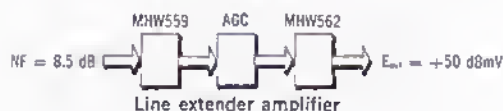
| Device Type | Gain 40-300 MHz Min/Typ | Maximum Distortion Specifications | | | | Noise Figure @ 300 MHz dB |
|-------------|----------------------------|-----------------------------------|---|---|---|---------------------------------|
| | | Output Level Note 1 dBmV | 2nd Order Test Note 2 dB / Frequency MHz | 3rd Order Test Note 2 dB / Frequency MHz | Cross-Modulation dB / No. of Channels | |
| MHW559 | 15.5/16 | +50 | -64/chs (2+13) @ ch R | -70/chs (4+5+A) @ ch R | -54/21 | 8.5 |
| MHW562 | 15.5/16 | +50 | -69/chs (2+13) @ ch R | -78/chs (4+5+A) @ ch R | -57/21 | 10 |
| MHW570 | 16/16.7 | +50 | -64/chs (2+13) @ ch R | -76/chs (4+5+A) @ ch R | -54/30 | 7.5 |
| MHW572 | 16/16.7 | +50 | -70/chs (2+13) @ ch R | -79/chs (4+5+A) @ ch R | -57/30 | 9.0 |
| MHW580 | 33/34 | +48 | -65/chs (3+M) @ ch W | -72/chs (U+V+W) @ ch W | -57/35 | 7.0 |

Notes:

1. 1.0 Millivolt Referenced to 75 Ohms.
2. Channel Frequency
ch 2 = 55 MHz, ch 3 = 61 MHz, ch 4 = 67 MHz, ch 5 = 77 MHz, ch A = 121 MHz,
ch 13 = 211 MHz, ch M = 325 MHz, ch R = 265 MHz, ch U = 283 MHz,
ch V = 289 MHz, ch W = 295 MHz.

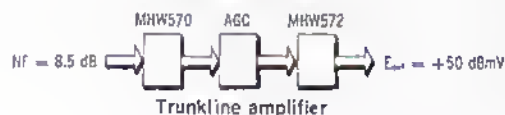
Chain 17 — CATV

GAIN ~ 30 dB (40-300 MHz)



Chain 18 — CATV

GAIN ~ 32 dB (40-300 MHz)



ENGINEERING BULLETIN ABSTRACTS

EB-8 — "NOW TO APPLY THE MNW709 AND MHW710 UHF POWER MODULES"

Discusses gain control, decoupling, source and load impedance, load mismatch and other operating conditions important to the effective use of the MNW709/710 series modules.

EB-9 — "BUILD THESE CLASS E CITIZENS BAND AMPLIFIERS"

Sufficient information is provided to build an amplifier/low pass filter using the MRF207/208 chain and providing 10 W at 225 MHz at the filter output. Use of the MRF225/226 chain in this circuit will provide 13 W.

EB-17 — "SIMPLE VHF BROADBAND DESIGN USES CQ TRANSISTOR LINEUP"

The fixed-tuned amplifier for the 132-175 MHz band described provides 40 W at 12.5 V from a 1.0 W input using the MRF216/MRF221 transistor chain.

EB-18 — "CQ MODULAR TECHNIQUES MAKE 45 WATT UHF AMPLIFIER PRACTICAL"

Provides construction information for a practical 45 W, 12.5 V UHF amplifier which uses a power module/transistor lineup. Lineups for outputs of 25 W and 35 W are also specified.

EB-19 — "CONTROLLED-Q RF TECHNOLOGY — WHAT IT MEANS, NOW IT'S DONE"

How high frequency energy is efficiently transferred from a signal source to the control element in Motorola's Controlled-Q transistors is explained.

EB-23 — "NOW TO APPLY THE MHW601/602 VHF POWER MODULES"

Discusses operation and testing considerations that should be followed to use the MHW601/602 VHF power modules to the best advantage. Gain control, decoupling, source and load impedances and load mismatch are treated and instructions for building a test fixture are also provided.

EB-25 — "FOUR BUILDING BLOCK AMPLIFIERS FOR 900 MHz COMMUNICATIONS"

Describes the use of a family of four 50 ohm amplifiers for the 900 MHz band to build amplifier chains with up to 50 W output from as little as 50 mW input.

EB-26 — "A METALLIZATION SYSTEM FOR UHF AND MICROWAVE POWER TRANSISTORS"

The metallization system described overcomes the limitations of aluminum under high current density conditions. Justification of the choice of metals for the system is provided in the discussion.

AN-555 — "MOUNTING STRIPLINE-OPPOSED-EMITTER (SOE) TRANSISTORS"

The basic construction of the Stripline-Opposed-Emitter package used for many RF power transistors is described. Methods of mounting and heat-sinking both stud and flange type packages are described.

AN-593 — "BROADBAND LINEAR POWER AMPLIFIERS USING PUSH-PULL TRANSISTORS"

Two solid-state linear power amplifiers are discussed. One provides 160 watts while operating from a 28 volt supply and the other provides 80 watts from a 12.5 volt supply.

AN-595 — "25 WATT AND 10 WATT VHF MARINE BAND TRANSMITTERS"

Design, performance and construction information are provided for two power amplifiers suitable for VHF marine band (156-162 MHz) applications. Rated power output levels are 25 watts and 10 watts.

AN-704 — "BROADBAND NETWORK DESIGN FOR UHF AMPLIFIERS"

A practical method to synthesize broadband matching networks for UHF power amplifier using only a set of taper design tables and a standard Smith chart is developed.

EB-27 — "GET 300 WATTS PEP LINEAR ACROSS 2 TO 30 MHz FROM THIS PUSH-PULL AMPLIFIER"

Provides information sufficient to build a push-pull linear amplifier with 300 watts of PEP or CW output power across the 2 to 30 MHz band. MRF422, a new high power transistor developed for single sideband applications, is used in the design.

EB-29 — "THE COMMON EMITTER TO-39 AND ITS ADVANTAGES"

Motorola's small signal package innovation — the common emitter TO-39 — offers designers significant improvements in gain and thermal performance. EB-29 explains how.

EB-31 — "PERFORMANCE OF THE MHW560 SERIES OF CATV AMPLIFIER MODULES IN SDN SYSTEMS"

The high gain, wideband linear characteristics of the MHW560 series of CATV amplifier modules suit them for use as low-level drivers in communications applications. EB-31 provides typical 50 ohm data and describes the test circuit with which the characteristics were derived.

EB-32 — "A COMPLEMENTARY SYMMETRY AMPLIFIER FOR 2 TO 30 MHz WITH SSB DRIVER APPLICATIONS"

The complementary symmetry amplifier discussed combines push-pull design with single ended impedance matching and high gain from Motorola's MRF432/433 transistors to provide up to 25 W PEP for 2 to 30 MHz SSB driver applications. Adequate information for constructing the circuit is included.

EB-37 — "AMPLIFIER GAINS 10 dB OVER NINE OCTAVES"

Discusses an amplifier, based on the MRF901 transistor, which exhibits a nominal gain of 10 dB over nine octaves of bandwidth. Sufficient information to build the amplifier is provided.

EB-38 — "MEASURING THE INTERMODULATION DISTORTION OF LINEAR AMPLIFIERS"

The two standard methods of measuring the intermodulation distortion of linear amplifiers and three systems for generating the required two-tone test signal are discussed.

EB-46 — "A SINGLE-DEVICE, 80-WATT, 50-OHM VHF AMPLIFIER"

EB-46 describes the design and construction of an amplifier using a single, MRF245, internally-matched transistor and providing 80 Watts with 9.5 gain across the 143 to 156 MHz band from just 8 W drive. Modifications of the basic amplifier for operation across wider bands are also discussed.

EB-53 — "TWO VHF HIGHBAND GAIN BLOCKS FORM 20 DB, 30-WATT AMPLIFIER CHAIN"

EB-53 describes an amplifier chain designed for use in a communications radio for the VHF marine band that can be adapted to both amateur and low-cost commercial usage. Built from MRF237, a 4 Watt common-emitter TD-39 transistor and MRD238, a 3030 Watt device, the amplifier chain provides 20 dB of gain over any 10 MHz portion of the VHF Marine/Amateur/Commercial band.

APPLICATION NOTE ABSTRACTS

AN-721 — "IMPEDANCE MATCHING NETWORKS APPLIED TO RF POWER TRANSISTORS"

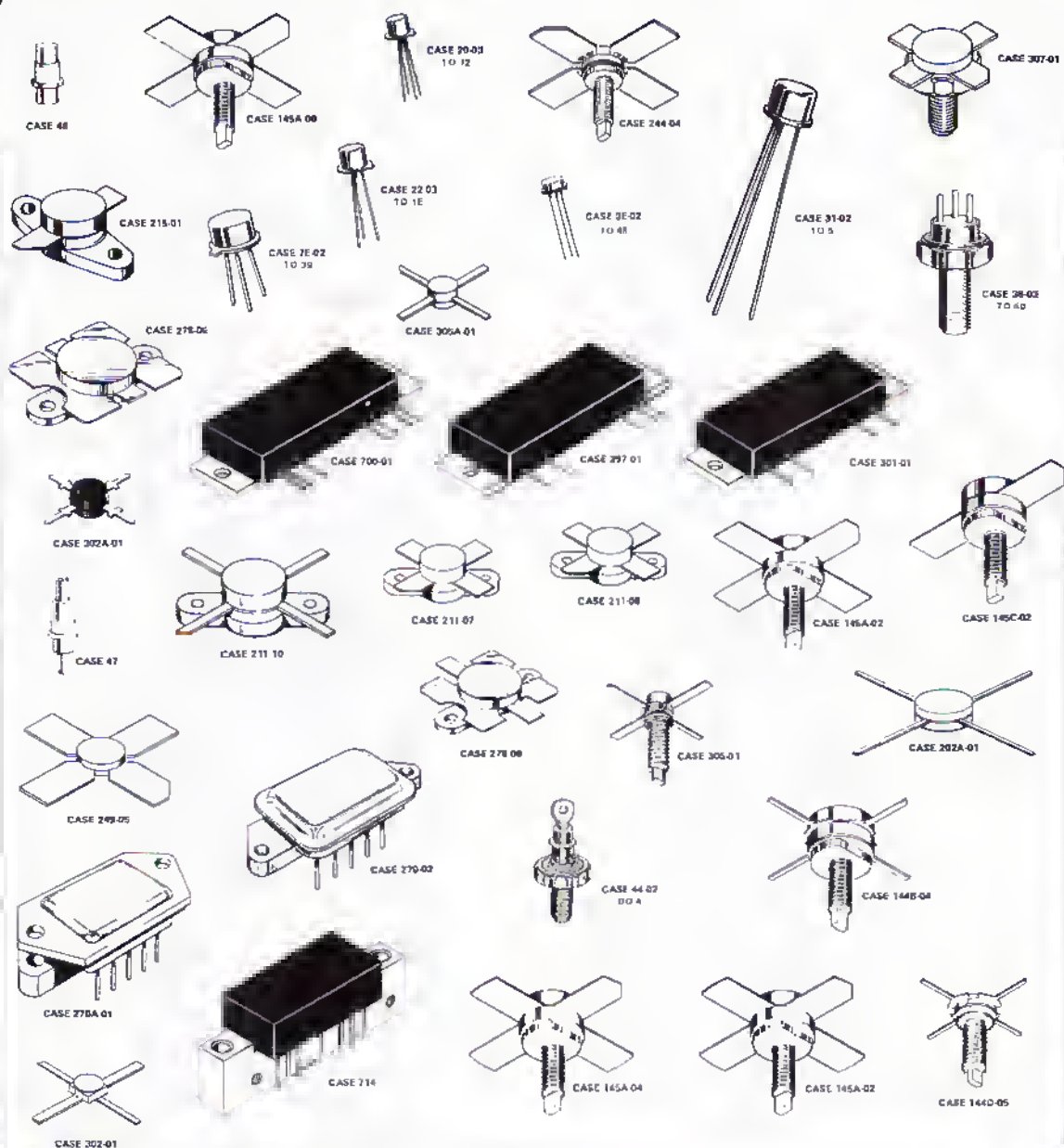
This note covers the basics of interstage and output impedance matching of RF power transistors. Graphical and numerical methods of solution are clearly described, along with sample problems. Photos, schematics and charts are generously provided throughout.

AN-728 — "13 WATT MICROSTRIP AMPLIFIER FOR 220-225 MHz OPERATION"

Design, performance and construction information are provided for a 12.5 volt, FM transmitter power amplifier and low pass filter. MRF225 and MRF226 RF power transistors are utilized in the two-stage amplifier to achieve 13 watts of power output to the filter from approximately 125 mW of drive at 225 MHz. Economical dipped-mica capacitors, microstrip lines and eyelet construction have been employed.

AN-749 — "BROADBAND TRANSFORMERS AND POWER COMBINING TECHNIQUES FOR RF"

This Application Note discusses broadband transformers for RF power applications. Practical examples are given with performance data and power combining techniques are discussed in detail.



PACKAGE INFORMATION

Silicon High Frequency products are available in a variety of packages for many applications. Information on devices in non-standard packaging may be obtained through your local Motorola Sales Office or Motorola distributor.



TUNING DIODES

... and Other VHF/UHF Devices

The age of electronic tuning and frequency control is here! Mechanical tuning systems are being outdated by the following advantages of electronic tuning systems:

- Mechanical linkage and contacts are eliminated.
- Channel or station changes can easily be made by push button, continuous tuning, signal search or sweep methods.
- Faster response time
- Remote tuning is simplified
- Tuning components are much smaller than mechanical components
- The designer is released from the mechanical and size restrictions dictated by mechanical tuning methods

Three parameters are of prime consideration in choosing the proper tuning diode.

C_T — Nominal capacitance — Measure of the capacitance at one specified voltage

C_R — Capacitance ratio — Ratio of the capacitance at two separate voltages usually at the operating ends of the CV curve. Measure of the magnitude of capacitance change as the reverse voltage is varied across the operating range.

Q — Figure of Merit — The same figure of merit that is widely used for capacitance and coils and is an indicator of how "good" a capacitor the tuning diode is.

These parameters are highlighted in the following selector guide and organized by package style to permit selection of the required specifications and package.

TABLE OF CONTENTS

Page

Epicap Tuning Diodes ... designed for electronic tuning and control applications ... 4-66

PIN Switching Diodes ... designed for VHF band switching and general-purpose switching ... 4-72

Hot-Carrier Diodes ... Ideal for VHF and UHF mixer and detector applications as well as ... 4-72
many higher microwave frequency applications

The following index reflects the devices characterized in this section. To locate the exact page number, see Catalog Index (Page 7-1).

INDEX





| | | | | | |
|----------|---------|----------|----------|---------|----------|
| 1N5139,A | 1N5462A | MB1101 | MV1622 | MV1863D | MV2113 |
| 1N5140,A | 1N5463A | MP1-3401 | MV1624 | MV1864D | MV2114 |
| 1N5141,A | 1N5464A | MPN3401 | MV1626 | MV1865D | MV2115 |
| 1N5142,A | 1N5465A | MPN3402 | MV1628 | MV1866 | MV3102 |
| 1N5143,A | 1N5466A | MPN3411 | MV1630 | MV1866D | MV3103 |
| 1N5144,A | 1N5467A | MPN3412 | MV1632 | MV1868 | MV3104 |
| 1N5145,A | 1N5468A | MV104 | * MV1634 | MV1868D | MV3105 |
| 1N5146,A | 1N5469A | MV104D | MV1636 | MV1870 | MV3106 |
| 1N5147,A | 1N5470A | MV109 | MV1638 | MV1870D | MV3107 |
| 1N5148,A | 1N5471A | MV209 | MV1640 | MV1871 | MV3140 |
| 1N5441A | 1N5472A | MV830 | MV1642 | MV1872 | MV3141 |
| 1N5442A | 1N5473A | MV831 | MV1644 | MV1874 | MV3142 |
| 1N5443A | 1N5476A | MV832 | MV1646 | MV1876 | MVAM-1 |
| 1N5444A | 1N5476A | MV833 | MV1648 | MV1877 | MVAM-2 |
| 1N5445A | BB106A | MB334 | MV1650 | MV1878 | MV1-2087 |
| 1N5446A | BB106B | MV836 | MV1662 | MV2101 | MV1-2098 |
| 1N5447A | BB106G | MV836 | MV1664 | MV2102 | MV1-2099 |
| 1N5448A | MBD101 | MV837 | MV1666 | MV2103 | MV1-2100 |
| 1N5449A | MBD102 | MV838 | MV1668 | MV2104 | MV1-2101 |
| 1N5450A | MBD103 | MV839 | MV1660 | MV2105 | MV1-2102 |
| 1N5451A | MBD201 | MV840 | MV1662 | MV2107 | MV1-2103 |
| 1N5452A | MBD301 | MV1401 | MV1664 | MV2108 | MV1-2104 |
| 1N5453A | MBD501 | MV1403 | MV1666 | MV2109 | MV1-2105 |
| 1N5455A | MBD602 | MV1404 | MV1668 | MV2110 | MV1-2106 |
| 1N5456A | MBD701 | MV1405 | MV1660 | MV2111 | MV1-2107 |
| 1N5461A | MSD702 | MV1620 | MV1862D | MV2112 | MV1-2108 |
| | | | | | MV1-2109 |

EPICAP TUNING DIODES

LINE HIGHLIGHTS

| | | | |
|---|--|--|---|
| <ul style="list-style-type: none"> • LOW CAPACITANCE • MICROWAVE OPERATION • MICROWAVE PACKAGE • HIGH Q | <ul style="list-style-type: none"> • HIGH Q • CAPACITANCE TOLERANCE 10% and 5.0% | <ul style="list-style-type: none"> • HIGH Q GUARANTEED @ 4.0 V • CONTROLLED TR | <ul style="list-style-type: none"> • THE PREMIUM GLASS LINE • VERY HIGH Q • GUARANTEED HIGH TR • CAPACITANCE TOLERANCE 10%, 5.0% and 2.0% |
|---|--|--|---|

MAXIMUM WORKING VOLTAGE 60 VOLTS

| | | | |
|---|---|---|---|
|  |  |  |  |
| Case 45 | Case 51 DO-7 | Case 51 DO-7 | Case 51 DO-7 |

| Cap Ratio 4-60 V Min | Q @ 4.0 V 100 MHz Min | Device Type | Cap Ratio 4-60 V Min | Q @ 4.0 V 50 MHz Min | (1) Device Type | Cap Ratio 4-60 V Min | Q @ 4.0 V 50 MHz Min | Device Type | Cap Ratio 2-30 V Min | Q @ 4.0 V 50 MHz Min | (2) Device Type |
|----------------------------|--------------------------------|----------------|----------------------------|-------------------------------|-----------------------|----------------------------|-------------------------------|----------------|----------------------------|-------------------------------|-----------------------|
| 2.1 | 350 | MV1858D | | | | | | | | | |
| 2.5 | 350 | MC1860D | | | | | | | | | |
| 2.6 | 300 | MC1862D | | | | | | | | | |
| 2.6 | 300 | MV1863D | | | | | | | | | |
| 2.7 | 300 | MV1864D | 2.7 | 350 | 1N5139,A(3) | | | | 2.7 | 600 | 1N5461A |
| 2.7 | 300 | MV1865D | | | | | | | 2.8 | 600 | 1N5462A |
| 2.8 | 250 | MV1866D | 2.8 | 300 | 1N5140,A | 3.0 | 500 | MV1866 | 2.8 | 550 | 1N5463A |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| 2.8 | 200 | MV1868D | 2.8 | 300 | 1N5141,A | 3.0 | 500 | MV1868 | 2.8 | 550 | 1N5464A |
| 2.8 | 200 | MV1870D | 2.8 | 250 | 1N5142,A | 3.0 | 400 | MV1870 | 2.8 | 550 | 1N5465A |
| | | | 2.8 | 250 | 1N5143,A | 3.0 | 400 | MV1871 | 2.8 | 500 | 1N5466A |
| | | | | | | | | | 2.9 | 500 | 1N5467A |
| | | | 3.2 | 200 | 1N5144,A | 3.2 | 400 | MV1872 | 2.9 | 500 | 1N5468A |
| | | | | | | | | | | | |
| | | | 3.2 | 200 | 1N5145,A | 3.2 | 300 | MV1874 | 2.9 | 500 | 1N5469A |
| | | | 3.2 | 200 | 1N5146,A | 3.2 | 300 | MV1876 | 2.8 | 500 | 1N5470A |
| | | | 3.2 | 200 | 1N5147,A | 3.2 | 300 | MV1877 | 2.9 | 450 | 1N5471A |
| | | | 3.2 | 200 | 1N5148,A | 3.2 | 300 | MV1878 | 2.9 | 400 | 1N5472A |
| | | | | | | | | | 2.9 | 300 | 1N5473A |
| | | | | | | | | | 2.9 | 250 | 1N5474A |
| | | | | | | | | | 2.9 | 225 | 1N5475A |
| | | | | | | | | | 2.9 | 200 | 1N5476A |
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C_T
 NOMINAL
 CAPACITANCE
 pF
 $\pm 10\%$
 @
 $V_R = 4.0 \text{ V}$
 $= 3.0 \text{ V}^*$
 $f = 1.0 \text{ MHz}$

(1) Add Suffix "A" for $\pm 5.0\%$ C_T tolerance

(2) Substitute "B" Suffix for $\pm 5.0\%$ C_T , "C" Suffix for 2.0% C_T

(3) A versions of 1N5139 - 1N5148 series have tighter capacitance min/max windows.

EPICAP TUNING DIODES (continued)

LINE HIGHLIGHTS

- HIGH Q
- IDEAL FOR RF AND MICROWAVE APPLICATIONS
- CONTROLLED AND UNIFORM TUNING RATIO
- CAPACITANCE TOLERANCE 10%
- MICRO-MINIATURE PACKAGE

MAXIMUM WORKING VOLTAGE

30 VOLTS



Case 226



Case 166-02

| Cap Ratio 2-30 V Min | Q @ 4.0 V 100 MHz Min | Device Type | Cap Ratio 2-30 V Min | Q @ 4.0 V 100 MHz Min | Device Type |
|-------------------------------|--------------------------------|----------------|-------------------------------|--------------------------------|----------------|
| | | | | | |
| 1.0 | | | 2.0 | 325 | MVI-2097 |
| 2.2 | | | 2.0 | 325 | MVI-2908 |
| 3.3 | | | 2.2 | 300 | MVI-2909 |
| 4.7 | | | 2.4 | 300 | MVI-2100 |
| 6.8 | 2.7 | 225 | 2.7 | 275 | MVI-2101 |
| 8.2 | 2.8 | 225 | 2.8 | 275 | MVI-2102 |
| 10 | 2.8 | 200 | 2.8 | 275 | MVI-2103 |
| 12 | 2.8 | 200 | 2.8 | 275 | MVI-2104 |
| 15 | 2.9 | 200 | 2.9 | 275 | MVI-2105 |
| 18 | 2.9 | 175 | 2.9 | 250 | MVI-2106 |
| 20 | | | | | |
| 22 | 2.9 | 175 | 2.9 | 200 | MVI-2107 |
| 27 | | | 2.7 | 200 | MVI-2108 |
| 33 | | | 2.7 | 200 | MVI-2109 |
| 39 | | | | | |
| 47 | | | | | |
| 56 | | | | | |
| 68 | | | | | |
| 82 | | | | | |
| 100 | | | | | |
| 120 | | | | | |
| 150 | | | | | |
| 180 | | | | | |
| 200 | | | | | |
| 220 | | | | | |
| 260 | | | | | |
| 270 | | | | | |
| 330 | | | | | |
| 550 | | | | | |

C_T
 NOMINAL
 CAPACITANCE
 pF
 ±10%
 @
 $V_R = 4.0 \text{ V}$
 $= 2.0 \text{ V}^\dagger$
 $= 1.0 \text{ V}^\bullet$
 $f = 1.0 \text{ MHz}$

* Motorola has capability to supply a variety of families in the Micro-I. If the device desired is not listed -- please contact your nearest distributor or Motorola Sales Representative.

| • GENERAL PURPOSE | | | • HIGH CAPACITANCE • GENERAL PURPOSE | | | • HYPER ABRUPT • GLASS DIODES | | | |
|-------------------------------|-------------------------------|----------------|---|-------------------------------|----------------|--|--------------------------------|----------------|-------|
| 20 VOLTS | | | | | | 12 VOLTS | | | |
| | | | | | | | | | |
| Case 51 DO-7 | | | Case 146 DO-14 | | | Case 51 DO-7 | | | |
| Cap Ratio 2-20 V Min | Q @ 4.0 V 50 MHz Min | Device Type | Cap Ratio 2-20 V Min | Q @ 4.0 V 20 MHz Min | Device Type | Cap Ratio 2-10 V #1-10 V Min | Q @ 2.0 V 1.0 MHz Min | Device Type | |
| | | | | | | | | | |
| | | | | | | | | 1.0 | |
| | | | | | | | | 2.2 | |
| | | | | | | | | 3.3 | |
| | | | | | | | | 4.7 | |
| 2.0 | 300 | MV1520 | | | | | | 6.8 | |
| 2.0 | 300 | MV1622 | | | | | | 6.2 | |
| 2.0 | 300 | MV1624 | | | | | | 10 | |
| 2.0 | 300 | MV1626 | | | | | | 12 | |
| 2.0 | 250 | MV1628 | | | | | | 15 | |
| 2.0 | 250 | MV1630 | | | | | | 18 | |
| 2.0 | 250 | MV1632 | | | | | | 20 | |
| 2.0 | 250 | MV1634 | | | | | | 22 | |
| 2.0 | 200 | MV1636 | | | | | | 27 | |
| 2.0 | 200 | MV1638 | | | | | | 33 | |
| 2.0 | 200 | MV1640 | | | | | | 39 | |
| 2.0 | 200 | MV1642 | | | | | | 47 | |
| 2.0 | 150 | MV1644 | | | | | | 56 | |
| 2.0 | 150 | MV1646 | | | | | | 68 | |
| 2.0 | 150 | MV1648 | | | | | | 82 | |
| 2.0 | 150 | MV1650 | | | | | | 100 | |
| | | | 2.6 | 250 | MV1652 | 10 | 200 | MV1404‡ | 120 |
| | | | 2.6 | 250 | MV1654 | 10 | 200 | MV1403‡ | 150 |
| | | | 2.6 | 200 | MV1656 | | | | 180 |
| | | | 2.6 | 200 | MV1658 | | | | 200 |
| | | | 2.6 | 150 | MV1660 | | | | 220 |
| | | | 2.3 | 160 | MV1662(3) | 10 | 200 | MV1405‡ | 250 |
| | | | 2.3 | 100 | MV1664(3) | | | | 270 |
| | | | 2.3 | 100 | MV1666(3) | | | | 330 |
| | | | | | | 14 | 200 | #MV1401‡ | 560 ● |

C_T
NOMINAL
CAPACITANCE
pF
±10%
@
V_R = 4.0 V
= 2.0 V‡
= 1.0 V
f = 1.0 MHz

C_T
 NOMINAL
 CAPACITANCE
 pF
 ±10%
 @
 $V_R = 4.0 \text{ V}$
 $= 2.0 \text{ V}^\ddagger$
 $= 1.0 \text{ V}$
 $f = 1.0 \text{ MHz}$

FM Radio and TV Hyper-Abrupt Tuning Diodes

... designed for use in VHF and UHF tuners and FM radio, providing solid-state reliability in replacement of mechanical tuning methods.

LINE HIGHLIGHTS

| | | | | |
|--|--|--|---|---|
| <ul style="list-style-type: none"> • HIGH Q • GUARANTEED CAPACITANCE RANGE | <ul style="list-style-type: none"> • LOW INDUCTANCE • MINI-L PACKAGE | <ul style="list-style-type: none"> • GUARANTEED MINIMUM Q • LOW INDUCTANCE • MINI-L PACKAGE | <ul style="list-style-type: none"> • HIGH Q • CONTROLLED TR • LOW INDUCTANCE • MINI-L PACKAGE | <ul style="list-style-type: none"> • HIGH Q • CONTROLLED TR • LOW INDUCTANCE • MINI-L PACKAGE |
|--|--|--|---|---|

MAXIMUM WORKING VOLTAGE 32 VOLTS

30 VOLTS



Case 29-02
TQ-92



Case 226



| | Cap Ratio 3-30 V Min | | | Q @ 3.0 V 100 MHz Min | | | Cap Ratio 3-25 V Min | | | Q @ 3.0 V 100 MHz Min | | | Cap Ratio 3-25 V Min | | | Q @ 3.0 V 60 MHz Min | | |
|---|----------------------|-----|-----|-----------------------|-----|--------|----------------------|-----|--------|-----------------------|-----|--------|----------------------|--|--|----------------------|-----|--|
| | Device Type | | | Device Type | | | Device Type | | | Device Type | | | Device Type | | | Device Type | | |
| C _T NOMINAL CAPACITANCE pF ±10% V _R = 3.0 Vdc f = 1.0 MHz | 2.2* | | | 4.5 | 225 | BB105B | | | | | | | | | | | | |
| | 2.3* | | | 4.0 | 150 | BB105G | | | | | | | | | | | | |
| | 2.6* | | | 4.0 | 225 | BB105A | | | | | | | | | | | | |
| | 10 | | | | | | 4.5 | 150 | MV3140 | | | | | | | | | |
| | 10 | | | | | | 4.0 | 150 | MV3141 | | | | | | | | | |
| | 10 | | | | | | 3.5 | 50 | MV3142 | | | | | | | | | |
| | 22 | | | | | | | | | 4.5 | 300 | MV3102 | | | | | | |
| | 22 | | | | | | | | | 4.0 | 200 | MV3103 | | | | | | |
| | 29 | | | | | | | | | | | | | | | 5.0 | 280 | |
| | 29 | | | | | | | | | | | | | | | 5.0 | 200 | |
| | 36 | 2.5 | 100 | MV104G | | | | | | | | | | | | | | |
| | 40 | 2.5 | 100 | MV104 | | | | | | | | | | | | | | |

*V_R = 25 V for C_T

AM Tuning Diodes

... designed for electronic tuning of AM radios, receivers, and general AM frequency control.



| | | | | | | | |
|---|---|----------------------------|---|---------------------------|----------------------------|--------------------------------|-----------------------------|
| <div>LINE HIGHLIGHTS</div> | <ul style="list-style-type: none">• HIGH CAPACITANCE RATIO• GUARANTEED DIODE CAPACITANCE | | <ul style="list-style-type: none">• HIGH CAPACITANCE RATIO• GUARANTEED DIODE CAPACITANCE | | | | |
| | MAXIMUM WORKING VOLTAGE 28 VOLTS | | | | | | |
| |  | |  | | | | |
| | CASE 29-02 TO-92 | | CASE 206-02 | | | | |
| | | Cap Ratio 1-25 V Min | Q @ 1.0 V 1.0 MHz Min | Device Type | Cap Ratio 1-25 V Min | Q @ 1.0 V 1.0 MHz Min | Device Type |
| C _T NDMINAL CAPACITANCE pF ±10% V _R = 1.0 V f = 1.0 MHz | 330 | 15 | 150 | MVAM-2 (Dual AM Diode) | | | |
| | 450 | | | | 15 | 150 | MVAM-1 (Triple AM Diode) |

Hot-Carrier Diodes

Hot-Carrier diodes are ideal for VHF and UHF mixer and detector applications as well as many higher microwave frequency applications. They provide stable electrical characteristics by eliminating the point-contact diode presently used in many applications. Motorola has the capability of supplying these devices in a variety of packages.

| $V_{(BR)R}$ $I_R = 10 \text{ A}$ Volts Min | C_T $V_R = 0 \text{ V}, f = 1.0 \text{ MHz}$ (1) $V_R = 15 \text{ V}, f = 1.0 \text{ MHz}$ (2) $V_R = 20 \text{ V}, f = 1.0 \text{ MHz}$ (3) pF Max | V_F $I_F = 10 \text{ mA}$ Volts Max | I_R $V_R = 3.0 \text{ V}$ (4) $V_R = 15 \text{ V}$ (5) $V_R = 25 \text{ V}$ (6) $V_R = 35 \text{ V}$ (7) μA Max | NF dB Max | Device Type | Case |
|---|---|--|---|-----------------|----------------|--------|
| 4.0 | 1.0 (1) | 0.6 | 0.25 (4) | 7.0 | MBD101 | 182-02 |
| 4.0 | 1.0 (1) | 0.6 | 0.25 (4) | 7.0 | MBD102 | 226 |
| 4.0 | 1.0 (1) | 0.6 | 0.25 (4) | 7.0 | MBD103 | 45-01 |
| 20 | 1.5 (2) | 0.6 | 200 (5) | | MBD201 | 182-03 |
| 30 | 1.5 (2) | 0.6 | 200 (6) | | MBD301 | 182-03 |
| 50 | 1.0 (3) | 1.2 | 200 (6) | | MBD501 | 182-02 |
| 50 | 1.0 (3) | 1.2 | 200 (6) | | MBD502 | 226 |
| 70 | 1.0 (3) | 1.2 | 200 (7) | | MBD701 | 182-02 |
| 70 | 1.0 (3) | 1.2 | 200 (7) | | MBD702 | 226 |
| 4.0 | 1.0 (1) | 0.6 | 0.25 (4) | 7.0 | MB1-101 | 166-02 |



CASE 45



CASE 166-02



CASE 182



CASE 226

Pin Switching Diodes

... designed for VHF band switching and general purpose switching.



CASE 166-02



CASE 226

| $V_{(BR)R}$ $I_R = 10 \mu\text{A dc}$ Volts Min | R_S $I_F = 10 \text{ mA dc}$ Ohms Min | C_T $V_R = 20 \text{ V}$ $f = 1.0 \text{ MHz}$ $f = 100 \text{ MHz}^*$ pF Max | L_S $f_v = 250 \text{ MHz}$ nH Typ | C_C $f = 1.0 \text{ MHz}$ pF Typ | Device Type | Case |
|--|--|---|---|---|----------------|--------|
| 35 | 0.7 | 1.0 | 3.0 | 0.15 | MPI-3401 | 166-02 |
| 35 | 0.7 | 1.0 | 3.0 | 0.1 | MPN3401 | 226 |
| 35 | 0.6 | 2.0 | 3.0 | 0.1 | MPN3402 | 226 |
| 25 | 10 | 0.45* | 3.0 | 0.1 | MPN3411 | 226 |
| 25 | 15 | 0.45* | 3.0 | 0.1 | MPN3412 | 226 |



ZENER DIODES

Voltage Regulator and Reference Devices

In every language under the sun, the name most commonly associated with solid-state regulator and reference devices is Motorola. A pioneer in Zener diodes development, Motorola has consistently led the industry in parameter improvements, packaging proliferation and specifications innovation. Today, Motorola serves the industry with an incomparable line of zener and avalanche regulator diodes, temperature compensated reference devices, and a host of integrated circuits designed to provide the exact degree of regulation required, at the point in the circuit or system where it can be used most conveniently at the lowest cost.

TABLE OF CONTENTS

| | Page |
|---|------|
| Zener and Avalanche Regulator Diodes | |
| Silicon-oxide to provide low leakage, sharp breakover "knees" and long-term stability. | 4-77 |
| Zener Reference Devices (Temperature Compensated) | |
| Consist of forward-biased silicon diode junctions in series with zener-breakdown diode to provide precise degree of temperature compensation. Though not specified, voltage-time stability normally better than 100 parts per million change per 1000 hours of operation. | 4-79 |
| Special Devices | |
| <u>Precision Reference Diodes</u> | |
| Ultra precision voltage standards with certified voltage-time variations as low as 5 ppm per 1000 hours of operation. | 4-80 |
| <u>Amplifying Regulator Diodes</u> | |
| Designed for use in regulated power supplies as a combination voltage reference element and error voltage amplifier, providing temperature compensation for excellent reference voltage stability. | 4-80 |
| <u>Field-Effect Current Regulator Diodes</u> | |
| Provide constant-current output over wider range of terminal voltage. Used in instrumentation (ramp and stair-step generators), over-current protection and other applications requiring a constant current between 0.22 and 4 mA (nom). | 4-80 |
| <u>Voltage Regulators</u> | |
| High-conductance silicon diodes designed as a stable forward reference source for biasing transistor amplifiers and similar applications. | 4-81 |
| <u>Current Limited Reference Devices (Temperature Compensated)</u> | |
| Designed specifically for precision instrumentation applications, this series of devices offers a 6.35 volt (nominal) output over a wide range of input voltages and temperature. | 4-81 |
| <u>Tuning Regulator Diodes</u> | |
| For use in television and FM radios that use variable capacitance diode tuners. | 4-81 |
| <u>Dual Diodes</u> | |
| Designed for use in low cost biasing, steering and voltage doubler applications. | 4-81 |
| <u>Transient Suppressors</u> | |
| For applications requiring protection of voltage sensitive equipment against high-energy voltage pulses. | 4-82 |

ZENER DIODES (continued)

The following index reflects the devices characterized in this section. To locate the exact page number, see Catalog Index (Page 7-1).

INDEX

| | | | | | | | |
|-----------------|---------------|----------|---------------|----------|----------|----------|--------|
| 4M, 64FR10 | 1N9458, J, TX | 1N2808&R | 1N3016&R | 1N3334&R | 1N4074 | 1N4060&R | 1N4749 |
| 4M1.38FR5 | 1N957 | 1N2809&R | 1N3016 | 1N3335&R | 1N4074A | 1N4561&R | 1N4760 |
| 4M1.36FR2 | 1N958 | 1N2810&R | 1N3017 | 1N3336&R | 1N4075 | 1N4562&R | 1N4761 |
| 4M2.04FR5 | 1N959 | 1N2811&R | 1N3018 | 1N3337&R | 1N4075A | 1N4563&R | 1N4762 |
| 4M2.04FR2 | 1N960 | 1N2813&R | 1N3019 | 1N3338&R | 1N4076 | 1N4564&R | 1N4763 |
| 1M110ZS10 | 1N981 | 1N2814&R | 1N3020 | 1N3339&R | 1N4076A | 1N4565 | 1N4764 |
| 1M120ZS10 | 1N962 | 1N2816&R | 1N3021 | 1N3340&R | 1N4077 | 1N4565A | 1N4765 |
| 1M130ZS10 | 1N963 | 1N2818&R | 1N3022 | 1N3342&R | 1N4077A | 1N4566 | 1N4766 |
| 1M140ZS10 | 1N964 | 1N2819&R | 1N3023 | 1N3343&R | 1N4078 | 1N4566A | 1N4767 |
| 1M160ZS10 | 1N965 | 1N2820&R | 1N3024 | 1N3346&R | 1N4078A | 1N4567 | 1N4768 |
| 1M180ZS10 | 1N966 | 1N2822&R | 1N3025 | 1N3347&R | 1N4079 | 1N4567A | 1N4769 |
| 1M200ZS10 | 1N967 | 1N2823&R | 1N3026 | 1N3349&R | 1N4079A | 1N4568 | 1N4770 |
| 1N429 | 1N988 | 1N2824&R | 1N3027 | 1N3350&R | 1N4080 | 1N4568A | 1N4771 |
| 1N746 | 1N969 | 1N2825&R | 1N3028 | 1N3503 | 1N4080A | 1N4569 | 1N4782 |
| 1N747 | 1N970 | 1N2826&R | 1N3029 | 1N3504 | 1N4081 | 1N4569A | 1N4783 |
| 1N748 | 1N971 | 1N2827&R | 1N3030 | 1N3821 | 1N4081A | 1N4570 | 1N4784 |
| 1N749 | 1N972 | 1N2829&R | 1N3031 | 1N3822 | 1N4082 | 1N4570A | 1N4785 |
| 1N750 | 1N973 | 1N2831&R | 1N3032 | 1N3823 | 1N4082A | 1N4571 | 1N4786 |
| 1N761 | 1N974 | 1N2832&R | 1N3033 | 1N3824 | 1N4083 | 1N4571A | 1N4787 |
| 1N752 | 1N975 | 1N2833&R | 1N3034 | 1N3825 | 1N4083A | 1N4572 | 1N4788 |
| 1N753 | 1N976 | 1N2834&R | 1N3035 | 1N3826 | 1N4084 | 1N4572A | 1N4789 |
| 1N754 | 1N977 | 1N2835&R | 1N3036 | 1N3827 | 1N4084A | 1N4573 | 1N4790 |
| 1N755 | 1N978 | 1N2836&R | 1N3037 | 1N3828 | 1N4085 | 1N4573A | 1N4791 |
| 1N756 | 1N979 | 1N2837&R | 1N3038 | 1N3829 | 1N4085A | 1N4574 | 1N4792 |
| 1N757 | 1N980 | 1N2838&R | 1N3039 | 1N3830 | 1N4089 | 1N4574A | 1N4793 |
| 1N768 | 1N981 | 1N2840&R | 1N3040 | 1N3993&R | 1N4100 | 1N4575 | 1N4794 |
| 1N759 | 1N982 | 1N2841&R | 1N3041 | 1N3994&R | 1N4101 | 1N4575A | 1N4795 |
| 1N816 | 1N983 | 1N2842&R | 1N3042 | 1N3995&R | 1N4103 | 1N4576 | 1N4796 |
| 1N821, J, TX | 1N984 | 1N2843&R | 1N3043 | 1N3996&R | 1N4104 | 1N4576A | 1N4797 |
| 1N821A | 1N985 | 1N2844&R | 1N3044 | 1N3997&R | 1N4105 | 1N4577 | 1N4798 |
| 1N823, J, TX | 1N986 | 1N2845&R | 1N3045 | 1N3998&R | 1N4106 | 1N4577A | 1N4799 |
| 1N823A | 1N987 | 1N2846&R | 1N3046 | 1N3999&R | 1N4107 | 1N4578 | 1N4800 |
| 1N825, J, TX | 1N988 | 1N2970&R | 1N3047 | 1N4000&R | 1N4109 | 1N4578A | 1N4801 |
| 1N825A | 1N989 | 1N2971&R | 1N3048 | 1N4057 | 1N4110 | 1N4579 | 1N4802 |
| 1N827, J, TX | 1N990 | 1N2972&R | 1N3049 | 1N4057A | 1N4112 | 1N4579A | 1N4803 |
| 1N827 | 1N991 | 1N2973&R | 1N3050 | 1N4058 | 1N4114 | 1N4580 | 1N4804 |
| 1N829, J, TX | 1N992 | 1N2974&R | 1N3051 | 1N4058A | 1N4115 | 1N4580A | 1N4805 |
| 1N829A | 1N1530 | 1N2975&R | 1N3154, J, TX | 1N4059 | 1N4116 | 1N4581 | 1N4806 |
| 1N935 | 1N1530A | 1N2976&R | 1N3154A | 1N4059A | 1N4118 | 1N4581A | 1N4807 |
| 1N935A | 1N1735 | 1N2977&R | 1N3155, J, TX | 1N4060 | 1N4120 | 1N4582 | 1N4808 |
| 1N935B, J, TX | 1N1738 | 1N2979&R | 1N3155A | 1N4060A | 1N4121 | 1N4582A | 1N4809 |
| 1N936 | 1N1735A | 1N2980&R | 1N3156, J, TX | 1N4061 | 1N4122 | 1N4583 | 1N4810 |
| 1N936A | 1N1737 | 1N2982&R | 1N3156A | 1N4061A | 1N4123 | 1N4583A | 1N4811 |
| 1N936B | 1N1737A | 1N2984&R | 1N3157, J, TX | 1N4062 | 1N4124 | 1N4584 | 1N4812 |
| 1N937 | 1N1738 | 1N2985&R | 1N3157A | 1N4062A | 1N4125 | 1N4584A | 1N4813 |
| 1N937A | 1N1738A | 1N2986&R | 1N3305&R | 1N4063 | 1N4126 | 1N4585 | 1N4814 |
| 1N937B, J, TX | 1N1739 | 1N2988&R | 1N3306&R | 1N4063A | 1N4127 | 1N4586 | 1N4815 |
| 1N938 | 1N1739A | 1N2989&R | 1N3307&R | 1N4064 | 1N4129 | 1N4587 | 1N4816 |
| 1N938A | 1N1740 | 1N2990&R | 1N3308&R | 1N4064A | 1N4130 | 1N4588 | 1N4817 |
| 1N938B, J, TX | 1N1740A | 1N2991&R | 1N3309&R | 1N4065 | 1N4131 | 1N4589 | 1N4818 |
| 1N939 | 1N1741 | 1N2992&R | 1N3310&R | 1N4065A | 1N4132 | 1N4590 | 1N4819 |
| 1N939A | 1N1741A | 1N2993&R | 1N3311&R | 1N4066 | 1N4134 | 1N4591 | 1N4820 |
| 1N939B, J, TX | 1N1742 | 1N2994&R | 1N3312&R | 1N4066A | 1N4135 | 1N4592 | 1N4821 |
| 1N941 | 1N1742A | 1N2995&R | 1N3313&R | 1N4067 | 1N4137 | 1N4593 | 1N4822 |
| 1N941A | 1N2163, A | 1N2996&R | 1N3314&R | 1N4067A | 1N4371 | 1N4594 | 1N4823 |
| 1N941, B, J, TX | 1N2164, A | 1N3000&R | 1N3315&R | 1N4068 | 1N4372 | 1N4595 | 1N4824 |
| 1N942 | 1N2165, A | 1N3001&R | 1N3316&R | 1N4068A | 1N4549&R | 1N4596 | 1N4825 |
| 1N942A | 1N2166, A | 1N3002&R | 1N3317&R | 1N4069 | 1N4550&R | 1N4597 | 1N4826 |
| 1N942B | 1N2167, A | 1N3003&R | 1N3318&R | 1N4069A | 1N4551&R | 1N4598 | 1N4827 |
| 1N943 | 1N2168, A | 1N3004&R | 1N3319&R | 1N4070 | 1N4552&R | 1N4599 | 1N4828 |
| 1N943A | 1N2169, A | 1N3005&R | 1N3320&R | 1N4070A | 1N4553&R | 1N4600 | 1N4829 |
| 1N943B, J, TX | 1N2170, A | 1N3006&R | 1N3321&R | 1N4071 | 1N4554&R | 1N4601 | 1N4830 |
| 1N944 | 1N2171, A | 1N3007&R | 1N3322&R | 1N4071A | 1N4555&R | 1N4602 | 1N4831 |
| 1N944A | 1N2804&R | 1N3008&R | 1N3323&R | 1N4072 | 1N4556&R | 1N4603 | 1N4832 |
| 1N944B, J, TX | 1N2805&R | 1N3009&R | 1N3324&R | 1N4072A | 1N4557&R | 1N4604 | 1N4833 |
| 1N945 | 1N2806&R | 1N3010&R | 1N3325&R | 1N4073 | 1N4558&R | 1N4605 | 1N4834 |
| 1N945A | 1N2807&R | 1N3011&R | 1N3326&R | 1N4073A | 1N4559&R | 1N4606 | 1N4835 |
| | | 1N3012&R | 1N3327&R | | | | |
| | | 1N3013&R | 1N3328&R | | | | |
| | | 1N3014&R | 1N3329&R | | | | |

INDEX (continued)

| | | | | | | | |
|---------|--------|---------|---------|---------|-----------|-----------|-----------|
| 1N4907A | 1N5242 | 1N5337 | 1N5844A | 1N5937 | MCA1912 | MZ4622 | MZC5.8B10 |
| 1N4908 | 1N5243 | 1N5338 | 1N5846A | 1N5938 | MCA1913 | MZ4623 | MZC7.6B10 |
| 1N4908A | 1N5245 | 1N5339 | 1N5846A | 1N5939 | MCA1914 | MZ4624 | MZC8.2B10 |
| 1N4909 | 1N5246 | 1N5341 | 1N5847A | 1N5940 | MCA1921 | MZ4625 | MZC9.1B10 |
| 1N4909A | 1N5248 | 1N5342 | 1N5848A | 1N5941 | MCA1922 | MZ4626 | MZC10B10 |
| 1N4910 | 1N5250 | 1N5343 | 1N5850A | 1N5842 | MCA1923 | MZ4827 | MZC11B10 |
| 1N4910A | 1N5251 | 1N5344 | 1N5851A | 1N5843 | MCA1924 | MZC2.4A10 | MZC12B10 |
| 1N4911 | 1N5252 | 1N5346 | 1N5862A | 1N5944 | MCA1931 | MZC2.7A10 | MZC13B10 |
| 1N4911A | 1N5254 | 1N5347 | 1N5863A | 1N5946 | MCA1932 | MZC3.0A10 | MZC15B10 |
| 1N4912 | 1N5256 | 1N5348 | 1N5865A | 1N5946 | MCA1933 | MZC3.3A10 | MZC16B10 |
| 1N4912A | 1N5257 | 1N5350 | 1N5868A | 1N5947 | MCA1934 | MZC3.6A10 | MZC18B10 |
| 1N4913 | 1N5258 | 1N5352 | 1N5867A | 1N5948 | MCA2011 | MZC3.9A10 | MZC20B10 |
| 1N4913A | 1N5259 | 1N5363 | 1N5888A | 1N5949 | MCA2012 | MZC4.3A10 | MZC22B10 |
| 1N4914 | 1N5260 | 1N5356 | 1N5889A | 1N5950 | MCA2013 | MZC4.7A10 | MZC24B10 |
| 1N4914A | 1N5261 | 1N5367 | 1N5861A | 1N5951 | MCA2014 | MZC5.1A10 | MZC27B10 |
| 1N4915 | 1N5262 | 1N5368 | 1N5862A | 1N5952 | MCA2021 | MZC5.6A10 | MZC30B10 |
| 1N4916A | 1N5263 | 1N5369 | 1N5864A | 1N5953 | MCA2022 | MZC5.2A10 | MZC33B10 |
| 1N4916 | 1N5265 | 1N5361 | 1N5866A | 1N5954 | MCA2023 | MZC6.8A10 | MZC36B10 |
| 1N4916A | 1N5266 | 1N5383 | 1N5867A | 1N5956 | MCA2024 | MZC7.6A10 | MZC39B10 |
| 1N4917 | 1N5267 | 1N5364 | 1N5868A | 1N5956 | MCA2031 | MZC8.2A10 | MZC43B10 |
| 1N4917A | 1N5268 | 1N5366 | 1N5870A | 1N5956 | MCA2132 | MZC9.1A10 | MZC47B10 |
| 1N4918 | 1N5270 | 1N5366 | 1N5872A | 1N5956 | MCA2133 | MZC10A10 | MZC51B10 |
| 1N4918A | 1N5271 | 1N5367 | 1N5873A | 1N5957 | MCA2134 | MZC11A10 | MZC56B10 |
| 1N4919 | 1N5272 | 1N5368 | 1N5874A | 1N5958 | MCA2211 | MZC12A10 | MZC62B10 |
| 1N4919A | 1N5273 | 1N5369 | 1N5876A | 1N5959 | MCA2212 | MZC13A10 | MZC68B10 |
| 1N4920 | 1N5274 | 1N5370 | 1N5876A | 1N5960 | MCA2213 | MZC15A10 | MZC75B10 |
| 1N4920A | 1N5275 | 1N5372 | 1N5877A | 1N5961 | MCA2214 | MZC16A10 | MZC82B10 |
| 1N4921 | 1N5276 | 1N5373 | 1N5878A | 1N5962 | MCA2221 | MZC18A10 | MZC91B10 |
| 1N4921A | 1N5277 | 1N5374 | 1N5879A | 1N5963 | MCA2222 | MZC20A10 | MZC100B10 |
| 1N4922 | 1N5278 | 1N5375 | 1N5881A | 1N5964 | MCA2223 | MZC22A10 | MZC110B10 |
| 1N4922A | 1N5279 | 1N5377 | 1N5882A | 1N5965 | MCA2224 | MZC24A10 | MZC120B10 |
| 1N4923 | 1N5281 | 1N5378 | 1N5883A | 1N5966 | MCA2231 | MZC27A10 | MZC130B10 |
| 1N4923A | 1N5283 | 1N5379 | 1N5884A | 1N5967 | MCA2232 | MZC30A10 | MZC140B10 |
| 1N4924 | 1N5284 | 1N5380 | 1N5886A | 1N5968 | MCA2233 | MZC33A10 | MZC150B10 |
| 1N4924A | 1N5285 | 1N5381 | 1N5887A | 1N5969 | MCA2234 | MZC36A10 | MZC160B10 |
| 1N4925 | 1N5286 | 1N5383 | 1N5888A | 1N6000 | MCL1300 | MZC39A10 | MZC170B10 |
| 1N4925A | 1N5287 | 1N5384 | 1N5889A | 1N6001 | MCL1301 | MZC43A10 | MZC180B10 |
| 1N4926 | 1N5288 | 1N5386 | 1N6000A | 1N6002 | MCL1302 | MZC47A10 | |
| 1N4926A | 1N5289 | 1N5388 | 1N5891A | 1N6003 | MCL1303 | MZC51A10 | |
| 1N4927 | 1N5290 | 1N5388 | 1N5892A | 1N6004 | MCL1304 | MZC56A10 | |
| 1N4927A | 1N5291 | 1N5519 | 1N5893A | 1N6005 | MCLTC6010 | MZC62A10 | |
| 1N4928 | 1N5292 | 1N5520 | 1N5894A | 1N6006 | MCLTC6025 | MZC68A10 | |
| 1N4928A | 1N5293 | 1N5521 | 1N5895A | 1N6007 | MCLTC6050 | MZC75A10 | |
| 1N4929 | 1N5294 | 1N5522 | 1N5897A | 1N6008 | MCLTC6100 | MZC82A10 | |
| 1N4929A | 1N5295 | 1N5523 | 1N5913 | 1N6009 | MSD6100 | MZC91A10 | |
| 1N4930 | 1N5296 | 1N5524 | 1N5914 | 1N6010 | MSD6101 | MZC100A10 | |
| 1N4930A | 1N5297 | 1N5525 | 1N5915 | 1N6011 | MSD6102 | MZC110A10 | |
| 1N4931 | 1N5298 | 1N5526 | 1N5916 | 1N6012 | MSD6150 | MZC120A10 | |
| 1N4931A | 1N5299 | 1N5527 | 1N5917 | 1N6013 | MSD7000 | MZC130A10 | |
| 1N4932 | 1N5300 | 1N5528 | 1N5918 | 1N6014 | MVS460 | MZC140A10 | |
| 1N4932A | 1N5301 | 1N5529 | 1N5919 | 1N6016 | MZ605 | MZC150A10 | |
| 1N5221 | 1N5302 | 1N5530 | 1N5920 | 1N6016 | MZ610 | MZC160A10 | |
| 1N5223 | 1N5303 | 1N5531 | 1N5921 | 1N6017 | MZ620 | MZC170A10 | |
| 1N5225 | 1N5304 | 1N5532 | 1N5922 | 1N6018 | MZ640 | MZC180A10 | |
| 1N5226 | 1N5305 | 1N5533 | 1N5923 | 1N6019 | MZB05 | MZC200A10 | |
| 1N5227 | 1N5306 | 1N5535 | 1N5924 | 1N6020 | MZ610 | MZC1.8B10 | |
| 1N5228 | 1N5307 | 1N5536 | 1N5925 | 1N6021 | MZ820 | MC22.0B10 | |
| 1N5229 | 1N5308 | 1N5538 | 1N5926 | 1N6022 | MZ840 | MC22.2B10 | |
| 1N5230 | 1N5309 | 1N5540 | 1N5927 | 1N6023 | MZ2360 | MC22.4B10 | |
| 1N5231 | 1N5310 | 1N5541 | 1N5928 | 1N6024 | MZ2361 | MC22.7B10 | |
| 1N5232 | 1N5311 | 1N5542 | 1N5929 | 1N6025 | MZ2362 | MC23.0B10 | |
| 1N5234 | 1N5312 | 1N5545 | 1N5930 | 1N6026 | MZ4614 | MZC3.3B10 | |
| 1N5236 | 1N5313 | 1N5546 | 1N5931 | 1N6027 | MZ4616 | MZC3.6B10 | |
| 1N5238 | 1N5314 | 1N5837A | 1N5932 | 1N6028 | MZ4617 | MZC3.9B10 | |
| 1N5237 | 1N5333 | 1N5839A | 1N5933 | 1N6029 | MZ4618 | MZC4.3B10 | |
| 1N5239 | 1N5334 | 1N5841A | 1N5934 | 1N6030 | MZ4619 | MZC4.7B10 | |
| 1N5240 | 1N5335 | 1N5842A | 1N5935 | 1N6031 | MZ4620 | MZC5.1B10 | |
| 1N5241 | 1N5336 | 1N5843A | 1N5936 | MCA1911 | MZ4621 | MZC5.6B10 | |
| | | | | | | MZC6.2B10 | |

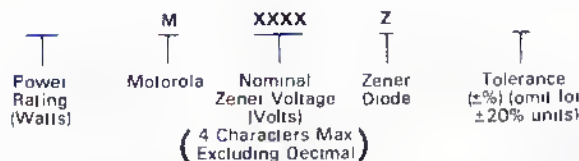
DEVICE OPTIONS

Motorola manufactures a complete line of zener diodes. In cases where a non-standard set of specifications is required, the appropriate device can be selected and ordered from the following device options.

NON-STANDARD ZENER DIODES SPECIAL VOLTAGE AND TOLERANCE RATINGS

JEDEC "IN" type numbers denote a specific Zener voltage, power rating, and tolerance. For example, JEDEC type 1N472B is a standard 1 watt diode, rated at 3.3 volts $\pm 10\%$. A suffix "A" on this type number indicates a $\pm 5\%$ voltage tolerance.

Special Motorola devices, with a choice of voltages and tolerances, are also available. The following diagram explains the Motorola coding system.



For example, the code for a special 10 watt Zener diode with a voltage of 41 volts and a tolerance of $\pm 1\%$ would be 10M41Z1.

Following is a list of other standard Motorola symbols for special Zener device orders (X's indicate nominal Zener voltage).

| BASIC MOTOROLA TYPE | DEVICE DESCRIPTION |
|---------------------|-------------------------------------|
| 1/4MXXXAZ5 | 250 mW Alloy Glass, $\pm 5\%$ |
| 1/4MXXXZ5 | 250 mW Glass, $\pm 5\%$ |
| 4MXXXAZ5 | 400 mW Alloy Glass, $\pm 5\%$ |
| 4MXXXZ10 | 400 mW Glass, $\pm 10\%$ |
| 5MXXXZS10 | 500 mW Surmetic, $\pm 10\%$ |
| 1MXXXZ5 | 1 Watt Flangeless, $\pm 5\%$ |
| 1MXXXAZ10 | 1 Watt Alloy Flangeless, $\pm 10\%$ |
| 1MXXXZ10 | 1 Watt Flangeless, $\pm 10\%$ |
| 1MXXXZ5 | 1 Watt Surmetic, $\pm 5\%$ |
| 15MXXXZ2 | 1.5 Watt, $\pm 20\%$ |
| 5MXXXZ5 | 5 Watt Surmetic, $\pm 5\%$ |
| 10MXXXAZ5 | 10 Watt Alloy Stud, $\pm 5\%$ |
| 10MXXXZ10 | 10 Watt Stud, $\pm 10\%$ |
| 50MXXXAZ10 | 50 Watt Alloy TO-3, $\pm 10\%$ |
| 50MXXXASZ5 | 50 Watt Alloy Stud, $\pm 5\%$ |
| 50MXXXZ2 | 50 Watt TO-3, $\pm 20\%$ |
| 50MXXXSZ5 | 50 Watt Stud, $\pm 5\%$ |

For reverse polarities (10 W and 50 W), insert "R" before tolerance, i.e., 50M110SZR5.

1N5518 thru 1N5546 — This series may be ordered in $\pm 2\%$ and $\pm 1\%$ tolerance by adding the following suffix.

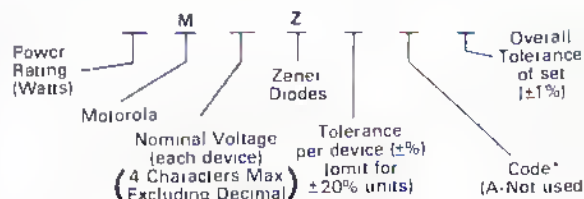
C = $\pm 2\%$ D = $\pm 1\%$

For example the 1N5518D would be the same as the 1N5518B except $V_Z = 3.3 \pm 1\%$.

ZENER TYPES BETWEEN NOMINAL VOLTAGES MATCHED SETS OF ZENER DIODES

Zener diodes can also be obtained in sets consisting of two or more matched devices. The method for specifying such matched sets is similar to the one described for specifying units with a special voltage and/or tolerance except that two extra suffixes are added to the code number described above.

These units are marked with code letters to identify the matched sets and in addition, each unit in a set is marked with the same serial number which is different for each set being ordered.

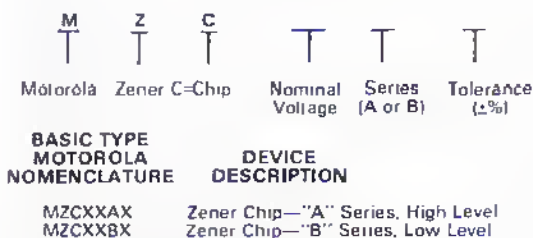


*Code:

- B — Two devices in series
 - C — Three devices in series
 - D — Four devices in series
 - E — Five devices in series
 - F — Six devices in series
 - G — Seven devices in series
 - H — Eight devices in series
 - P — Two devices in parallel (not recommended)
 - X — Two devices, one standard polarity, the other reverse polarity (10 and 50 watts only)
- i.e., 10M51Z5B1 is for two 10 watt zeners, each of 51 volts, $\pm 5\%$ matched to a total voltage of 102 volts $\pm 1\%$.

ZENER CHIPS (MZC)

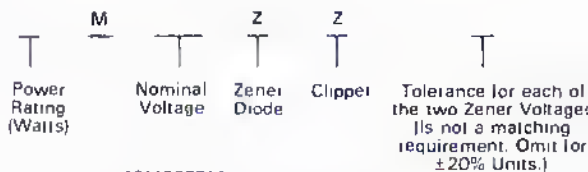
1. The nomenclature for Zener Chips is as follows:



2. Chips are sold in increments of ten (10) only.
3. The pricing formula for between nominal voltages and tight tolerance zeners shall apply.
4. Chips are not sold as matched sets or clipper.
5. A "1" suffix will cause all chips ordered to be supplied in Deka-Pak.

ZENER CLIPPERS

Special clipper diodes with opposing Zener junctions built into the device are available by using the following nomenclature:



i.e., 10M20ZZ10

This nomenclature is applicable to all packages and power ratings as restricted in the above paragraphs.

ORDERING INFORMATION

Order using the above nomenclature or else specify the device type, nominal voltage and tolerance required.

ZENER and AVALANCHE REGULATOR DIODES

The devices depicted in the accompanying matrix represent a basic profile of the largest inventoried zener-diode line in the industry. Check the following features for application to your specific requirements.

Wide selection of package materials and styles:

Plastic (surmetic), for lowest cost

Glass for highest reliability

Metal for highest power

Unencapsulated (chips), for hybrid circuit applications

| Nominal Zener Voltage (Note 6) | CHIPS (25 Mils Square) Cathode - Bottom Surface | | 250 MILLIWATT (400 mW Package) Cathode - Polarity Mark | 400 MILLIWATT Cathode - Polarity Mark | | 500 MILLIWATT Cathode - Polarity Mark | | |
|-----------------------------------|---|-------------|--|--|--------------------------|--|----------------------------------|---------------------------------|
| | MZC | Actual Size | Glass Case 51 (DO-7) | Glass Case 299 DO-35 | Glass Case 51 DO-7 | Surmetic Case 182 (TO-92) | Surmetic 20 Case 51 (DO-7) | Glass Case 299-01 (DO-35) |
| 1.8 | | MZC1.8B10 | MZ4614 | | | | | |
| 2.0 | | MZC2.0B10 | MZ4616 | | | | | |
| 2.2 | | MZC2.2B10 | MZ4618 | | | | | |
| 2.4 | MZC2.4A10 | MZC2.4B10 | MZ4617 | 1N4370 | | 1N5837A | 1N5221 | 1N5985 |
| 2.7 | MZC2.7A10 | MZC2.7B10 | MZ4618 | 1N4371 | | 1N5839A | 1N5223 | 1N5986 |
| 3.0 | MZC3.0A10 | MZC3.0B10 | MZ4619 | 1N4372 | | 1N5841A | 1N5225 | 1N5987 |
| 3.3 | MZC3.3A10 | MZC3.3B10 | MZ4620 | 1N746 | 1N5518 | 1N5842A | 1N5226 | 1N5988 |
| 3.6 | MZC3.6A10 | MZC3.6B10 | MZ4621 | 1N747 | 1N5519 | 1N5843A | 1N5227 | 1N5989 |
| 3.8 | MZC3.8A10 | MZC3.8B10 | MZ4622 | 1N748 | 1N5520 | 1N5844A | 1N5228 | 1N5990 |
| 4.3 | MZC4.3A10 | MZC4.3B10 | MZ4623 | 1N749 | 1N5521 | 1N5845A | 1N5229 | 1N5991 |
| 4.7 | MZC4.7A10 | MZC4.7B10 | MZ4624 | 1N750 | 1N5522 | 1N5846A | 1N5230 | 1N5992 |
| 5.1 | MZC5.1A10 | MZC5.1B10 | MZ4625 | 1N761 | 1N5523 | 1N5847A | 1N5231 | 1N5993 |
| 5.6 | MZC5.6A10 | MZC5.6B10 | MZ4626 | 1N752 | 1N5524 | 1N5848A | 1N5232 | 1N5994 |
| 6.2 | MZC6.2A10 | MZC6.2B10 | MZ4627 | 1N753 | 1N5525 | 1N5850A | 1N5234 | 1N5995 |
| 8.8 | MZC8.8A10 | MZC8.8B10 | 1N4099 | 1N754 1N957 | 1N5526 | 1N5851A | 1N5235 | 1N5996 |
| 7.5 | MZC7.5A10 | MZC7.5B10 | 1N4100 | 1N755 1N958 | 1N5527 | 1N5852A | 1N5236 | 1N5997 |
| 8.2 | MZC8.2A10 | MZC8.2B10 | 1N4101 | 1N756 1N959 | 1N5528 | 1N5853A | 1N5237 | 1N5998 |
| 9.1 | MZC9.1A10 | MZC9.1B10 | 1N4103 | 1N757 1N960 | 1N5529 | 1N5855A | 1N5239 | 1N5999 |
| 10 | MZC10A10 | MZC10B10 | 1N4104 | 1N758 1N861 | 1N5530 | 1N5856A | 1N5240 | 1N6000 |
| 11 | MZC11A10 | MZC11B10 | 1N4105 | 1N962 | 1N5531 | 1N5857A | 1N5241 | 1N6001 |
| 12 | MZC12A10 | MZC12B10 | 1N4106 | 1N769 1N963 | 1N5532 | 1N5858A | 1N5242 | 1N6002 |
| 13 | MZC13A10 | MZC13B10 | 1N4107 | 1N964 | 1N5533 | 1N5859A | 1N5243 | 1N6003 |
| 15 | MZC15A10 | MZC15B10 | 1N4108 | 1N965 | 1N5535 | 1N5861A | 1N5245 | 1N6004 |
| 18 | MZC18A10 | MZC18B10 | 1N4110 | 1N966 | 1N5536 | 1N5862A | 1N5246 | 1N6005 |
| 18 | MZC18A10 | MZC18B10 | 1N4112 | 1N967 | 1N5538 | 1N5864A | 1N5248 | 1N6006 |
| 20 | MZC20A10 | MZC20B10 | 1N4114 | 1N968 | 1N5540 | 1N5866A | 1N5250 | 1N6007 |
| 22 | MZC22A10 | MZC22B10 | 1N4115 | 1N969 | 1N5541 | 1N5867A | 1N5251 | 1N6008 |
| 24 | MZC24A10 | MZC24B10 | 1N4116 | 1N970 | 1N5542 | 1N5868A | 1N5252 | 1N6009 |
| 27 | MZC27A10 | MZC27B10 | 1N4118 | 1N971 | | 1N5870A | 1N5254 | 1N6010 |
| 30 | MZC30A10 | MZC30B10 | 1N4120 | 1N972 | 1N5545 | 1N5872A | 1N5256 | 1N6011 |
| 33 | MZC33A10 | MZC33B10 | 1N4121 | 1N973 | 1N5546 | 1N5873A | 1N5257 | 1N6012 |
| 38 | MZC38A10 | MZC38B10 | 1N4122 | 1N974 | | 1N5874A | 1N5258 | 1N6013 |
| 39 | MZC39A10 | MZC39B10 | 1N4123 | 1N975 | | 1N5876A | 1N5259 | 1N6014 |
| 43 | MZC43A10 | MZC43B10 | 1N4124 | 1N976 | | 1N5878A | 1N5260 | 1N6015 |
| 47 | MZC47A10 | MZC47B10 | 1N4125 | 1N977 | | 1N5879A | 1N5261 | 1N6016 |
| 51 | MZC51A10 | MZC51B10 | 1N4126 | 1N978 | | 1N5880A | 1N5262 | 1N6017 |
| 56 | MZC56A10 | MZC56B10 | 1N4127 | 1N979 | | 1N5881A | 1N5263 | 1N6018 |
| 62 | MZC62A10 | MZC62B10 | 1N4129 | 1N980 | | 1N5882A | 1N5264 | 1N6019 |
| 68 | MZC68A10 | MZC68B10 | 1N4130 | 1N981 | | 1N5883A | 1N5265 | 1N6020 |
| 75 | MZC75A10 | MZC75B10 | 1N4131 | 1N982 | | 1N5884A | 1N5267 | 1N6021 |
| 82 | MZC82A10 | MZC82B10 | 1N4132 | 1N983 | | 1N5885A | 1N5268 | 1N6022 |
| 81 | MZC81A10 | MZC81B10 | 1N4134 | 1N984 | | 1N5886A | 1N5270 | 1N6023 |
| 100 | MZC100A10 | MZC100B10 | 1N4135 | 1N985 | | 1N5887A | 1N5271 | 1N6024 |
| 110 | MZC110A10 | MZC110B10 | | 1N986 | | 1N5888A | 1N5272 | 1N6025 |
| 120 | MZC120A10 | MZC120B10 | | 1N987 | | 1N5889A | 1N5273 | 1N6026 |
| 130 | MZC130A10 | MZC130B10 | | 1N988 | | 1N5890A | 1N5274 | 1N6027 |
| 140 | MZC140A10 | MZC140B10 | | 1N989 | | 1N5891A | 1N5275 | |
| 150 | MZC150A10 | MZC150B10 | | 1N990 | | 1N5892A | 1N5276 | 1N6028 |
| 160 | MZC160A10 | MZC160B10 | | 1N991 | | 1N5893A | 1N5277 | 1N6029 |
| 170 | MZC170A10 | MZC170B10 | | 1N992 | | 1N5894A | 1N5278 | |
| 180 | MZC180A10 | MZC180B10 | | | | 1N5895A | 1N5279 | 1N6030 |
| 200 | MZC200A10 | MZC200B10 | | | | 1N5897A | 1N5281 | 1N6031 |

Chips:

A denotes 127 in mA range

B denotes 127 in 250 μ A

JAN/JANTX available $\pm 5\%$ only

ZENER AND AVALANCHE REGULATOR DIODES (continued)

- Power ratings from 1.4 to 50 Watts
- Breakover tolerances from 1.8 to 200 V in approximately 10% steps
- Available tolerances from 20% (low cost) to as tight as 1% (critical applications) with off-the-shelf delivery
- Special selection of electrical characteristics available at low cost due to high-volume lines (check your Motorola sales representative for special quotations)
- JAN/JANTX (V) availability

| Nominal Zener Voltage | 1 WATT | 1 WATT | 1 WATT | 5 WATT | 10 WATT | 50 WATT | |
|-----------------------|-----------------------|-----------------|-----------------------|-----------------------|--|---------------|----------|
| | Cathode Polarity Mark | Cathode to Case | Cathode Polarity Mark | Cathode Polarity Mark | Cathode to Case = 1N3993 Series Anode to Case = 1N2970 Series | Anode to Case | |
| | | | | | | | |
| 1.8 | | | | | | | |
| 2.0 | | | | | | | |
| 2.2 | | | | | | | |
| 2.4 | | | | | | | |
| 2.7 | | | | | | | |
| 3.0 | | | | | | | |
| 3.3 | 1N4728 | 1N3831 | 1N5913 | 1N5333 | | | |
| 3.6 | 1N4729 | 1N3822 | 1N5914 | 1N5334 | | | |
| 3.9 | 1N4730 | 1N3823 | 1N5915 | 1N5335 | 1N3993&R | 1N4557&R | 1N4549&R |
| 4.3 | 1N4731 | 1N3834 | 1N5916 | 1N5336 | 1N3994&R | 1N4558&R | 1N4550&R |
| 4.7 | 1N4732 | 1N3835 | 1N5917 | 1N5337 | 1N3995&R | 1N4559&R | 1N4551&R |
| 5.1 | 1N4733 | 1N3826 | 1N5918 | 1N5338 | 1N3996&R | 1N4560&R | 1N4552&R |
| 5.6 | 1N4734 | 1N3827 | 1N5919 | 1N5339 | 1N3997&R | 1N4561&R | 1N4553&R |
| 6.2 | 1N4735 | 1N3828 | 1N5920 | 1N5341 | 1N3998&R | 1N4562&R | 1N4554&R |
| 6.8 | 1N4736 | 1N3829 | 1N5931 | 1N5342 | 1N3999&R | 1N4563&R | 1N4555&R |
| | | 1N3018 | | | 1N2970&R | 1N2804&R | 1N3305&R |
| 7.5 | 1N4737 | 1N3830 | 1N5932 | 1N5343 | 1N4000&R | 1N4564&R | 1N4556&R |
| | | 1N3017 | | | 1N2971&R | 1N2805&R | 1N3306&R |
| 8.2 | 1N4738 | 1N3018 | 1N5933 | 1N5344 | 1N2972&R | 1N2806&R | 1N3307&R |
| 9.1 | 1N4739 | 1N3019 | 1N5924 | 1N5345 | 1N3973&R | 1N2807&R | 1N3308&R |
| 10 | 1N4740 | 1N3030 | 1N5925 | 1N5347 | 1N2974&R | 1N2808&R | 1N3309&R |
| 11 | 1N4741 | 1N3021 | 1N5926 | 1N5348 | 1N3975&R | 1N2809&R | 1N3310&R |
| 12 | 1N4742 | 1N3023 | 1N5927 | 1N5349 | 1N2976&R | 1N2810&R | 1N3311&R |
| 13 | 1N4743 | 1N3023 | 1N5938 | 1N5350 | 1N2977&R | 1N2811&R | 1N3313&R |
| 15 | 1N4744 | 1N3024 | 1N5939 | 1N5352 | 1N2979&R | 1N2813&R | 1N3314&R |
| 16 | 1N4745 | 1N3035 | 1N5930 | 1N5353 | 1N2980&R | 1N2814&R | 1N3315&R |
| 18 | 1N4746 | 1N3026 | 1N5931 | 1N5355 | 1N3982&R | 1N2816&R | 1N3317&R |
| 20 | 1N4747 | 1N3037 | 1N5932 | 1N5357 | 1N3984&R | 1N2818&R | 1N3319&R |
| 22 | 1N4748 | 1N3038 | 1N5933 | 1N5358 | 1N2885&R | 1N2819&R | 1N3320&R |
| 24 | 1N4749 | 1N3029 | 1N5934 | 1N5358 | 1N3986&R | 1N2820&R | 1N3321&R |
| 27 | 1N4750 | 1N3030 | 1N5935 | 1N5381 | 1N2888&R | 1N2822&R | 1N3323&R |
| 30 | 1N4751 | 1N3031 | 1N5938 | 1N5383 | 1N2989&R | 1N3823&R | 1N3324&R |
| 33 | 1N4753 | 1N3032 | 1N5937 | 1N5384 | 1N2990&R | 1N3824&R | 1N3325&R |
| 36 | 1N4752 | 1N3033 | 1N5938 | 1N5385 | 1N2991&R | 1N2825&R | 1N3326&R |
| 39 | 1N4754 | 1N3034 | 1N5939 | 1N5386 | 1N2993&R | 1N2826&R | 1N3327&R |
| 43 | 1N4755 | 1N3035 | 1N5940 | 1N5387 | 1N3983&R | 1N2827&R | 1N3328&R |
| 47 | 1N4756 | 1N3036 | 1N5941 | 1N5388 | 1N3985&R | 1N2829&R | 1N3330&R |
| 51 | 1N4757 | 1N3037 | 1N5943 | 1N5369 | 1N2997&R | 1N2831&R | 1N3332&R |
| 56 | 1N4758 | 1N3038 | 1N5943 | 1N5370 | 1N3998&R | 1N3933&R | 1N3334&R |
| 62 | 1N4759 | 1N3039 | 1N5944 | 1N5373 | 1N3000&R | 1N2833&R | 1N3335&R |
| 68 | 1N4760 | 1N3040 | 1N5945 | 1N5373 | 1N3001&R | 1N3834&R | 1N3336&R |
| 75 | 1N4761 | 1N3041 | 1N5946 | 1N5374 | 1N3002&R | 1N2835&R | 1N3337&R |
| 82 | 1N4762 | 1N3042 | 1N5947 | 1N5375 | 1N3003&R | 1N2836&R | 1N3338&R |
| 91 | 1N4763 | 1N3043 | 1N5948 | 1N5377 | 1N3004&R | 1N2837&R | 1N3339&R |
| 100 | 1N4764 | 1N3044 | 1N5949 | 1N5378 | 1N3005&R | 1N2838&R | 1N3340&R |
| 110 | 1M1102S10 | 1N3045 | 1N5950 | 1N5379 | 1N3007&R | 1N2840&R | 1N3342&R |
| 120 | 1M1202S10 | 1N3046 | 1N5951 | 1N5380 | 1N3008&R | 1N2841&R | 1N3343&R |
| 130 | 1M1302S10 | 1N3047 | 1N5952 | 1N5381 | 1N3009&R | 1N2842&R | 1N3344&R |
| 150 | 1M1402S10 | 1N3048 | 1N5953 | 1N5383 | 1N3011&R | 1N2843&R | 1N3346&R |
| 160 | 1M1602S10 | 1N3049 | 1N5954 | 1N5384 | 1N3012&R | 1N2844&R | 1N3347&R |
| 180 | 1M1802S10 | 1N3050 | 1N5955 | 1N5386 | 1N3014&R | 1N2845&R | 1N3349&R |
| 200 | 1M2002S10 | 1N3051 | 1N5956 | 1N5388 | 1N3015&R | 1N2846&R | 1N3350&R |

R, RA, & RB = Reverse Polarity Types Available

ZENER REFERENCE DEVICES



For applications where output voltage must remain within narrow limits during changes in input voltage, load resistance and temperature, Motorola guarantees all Reference Devices to fall within the specified maximum voltage variations, ΔV_Z , at the specifically indicated test temperatures and test current (JEDEC Standard #5). Temperature Coefficient is also specified but should be

considered as a reference only — not a maximum rating.

The low voltage devices are hermetically sealed, all-glass structure. Includes JAN; JANTX and radiation hardened device types. These temperature compensated Zener Reference Diodes have low dynamic impedance and silicon-oxide-passivated junctions for long term stability.

| V _Z Volts | Test Current mA _{dc} | Test Temp Points | AVERAGE TEMPERATURE COEFFICIENT OVER THE OPERATING RANGE | | | | | | | | | |
|---|-------------------------------------|------------------------|--|--------------------------------|------------------|--------------------------------|------------------|--------------------------------|------------------|--------------------------------|------------------|--------------------------------|
| | | | 0.01 %/°C | | 0.005 %/°C | | 0.002 %/°C | | 0.001 %/°C | | 0.0005 %/°C | |
| | | | Device Type | V _Z Max Volts | Device Type | V _Z Max Volts | Device Type | V _Z Max Volts | Device Type | V _Z Max Volts | Device Type | V _Z Max Volts |
| 5.2 Δ | 7.5 | A | *1N821, J,TX | 0.095 | *1N823, J,TX | 0.048 | *1N825, J,TX | 0.019 | *1N827, J,TX | 0.009 | *1N829, J,TX | 0.005 |
| 5.2 Δ | 7.5 | A | *1N821A | 0.096 | *1N823A | 0.048 | *1N825A | 0.018 | *1N827A | 0.009 | *1N829A | 0.005 |
| 6.4 | 0.5 | B | 1N4555 | 0.018 | 1N4555 | 0.024 | 1N4557 | 0.010 | 1N4558 | 0.005 | 1N4559 | 0.002 |
| | 0.5 | A | 1N4555A | 0.099 | 1N4555A | 0.050 | 1N4557A | 0.020 | 1N4558A | 0.010 | 1N4559A | 0.005 |
| | 1.0 | B | 1N4570 | 0.048 | 1N4571 | 0.024 | 1N4572 | 0.010 | 1N4573 | 0.005 | 1N4574 | 0.002 |
| | 1.0 | A | 1N4570A | 0.099 | 1N4571A | 0.050 | 1N4572A | 0.020 | 1N4573A | 0.010 | 1N4574A | 0.005 |
| | 2.0 | B | 1N4575 | 0.048 | 1N4576 | 0.024 | 1N4577 | 0.010 | 1N4578 | 0.005 | 1N4579 | 0.002 |
| | 2.0 | A | 1N4575A | 0.099 | 1N4576A | 0.025 | 1N4577A | 0.020 | 1N4578A | 0.010 | 1N4579A | 0.005 |
| | 4.0 | B | 1N4580 | 0.048 | 1N4581 | 0.024 | 1N4582 | 0.010 | 1N4583 | 0.005 | 1N4584 | 0.002 |
| | 4.0 | A | 1N4580A | 0.099 | 1N4581A | 0.050 | 1N4582A | 0.020 | 1N4583A | 0.010 | 1N4584A | 0.005 |
| 8.4 | 10 | A | *1N3154, J,TX | 0.130 | *1N3155, J,TX | 0.065 | *1N3156, J,TX | 0.026 | *1N3157, J,TX | 0.013 | | |
| | 10 | C | *1N3154A | 0.072 | *1N3155A | 0.085 | *1N3156A | 0.034 | *1N3157A | 0.017 | | |
| 8.5 | 0.5 | B | 1N4775 | 0.064 | 1N4776 | 0.032 | 1N4777 | 0.013 | 1N4778 | 0.006 | 1N4778 | 0.003 |
| | 0.5 | A | 1N4775A | 0.132 | 1N4776A | 0.066 | 1N4777A | 0.026 | 1N4778A | 0.013 | 1N4779A | 0.007 |
| | 1.0 | B | 1N4780 | 0.064 | 1N4781 | 0.032 | 1N4782 | 0.013 | 1N4783 | 0.006 | 1N4784 | 0.003 |
| | 1.0 | A | 1N4780A | 0.132 | 1N4781A | 0.066 | 1N4782A | 0.026 | 1N4783A | 0.013 | 1N4784A | 0.007 |
| 9.0 | 7.5 | B | *1N935 | 0.057 | *1N936 | 0.033 | *1N937 | 0.013 | *1N938 | 0.006 | *1N939 | 0.003 |
| | 7.5 | A | *1N935A | 0.139 | *1N936A | 0.069 | *1N937A | 0.027 | *1N938A | 0.013 | *1N939A | 0.007 |
| | 7.5 | C | *1N935B, J,TX | 0.184 | *1N935B | 0.092 | *1N937B, J,TX | 0.037 | *1N938B, J,TX | 0.018 | *1N939B, J,TX | 0.005 |
| 9.4 ± 0.4 (Suffix "A" ± 0.2 V) | 10 | D | | | 1N2153A | 0.033 | | | 1N2155A | 0.007 | 1N2169A | 0.004 |
| | | E | | | 1N2154A | 0.085 | | | 1N2157A | 0.017 | 1N2170A | 0.009 |
| | | F | | | 1N2155A | 0.110 | | | 1N2158A | 0.023 | 1N2171A | 0.012 |
| 11.7 | 7.5 | B | *1N941 | 0.088 | *1N942 | 0.044 | *1N943 | 0.018 | *1N944 | 0.009 | *1N945 | 0.004 |
| | 7.5 | A | *1N941A | 0.081 | *1N942A | 0.090 | *1N943A | 0.036 | *1N944A | 0.018 | *1N945A | 0.009 |
| | 7.5 | C | *1N941B, J,TX | 0.239 | *1N942B | 0.120 | *1N943B, J,TX | 0.047 | *1N944B, J,TX | 0.024 | *1N945B, J,TX | 0.012 |
| 12.8 | 0.5 | G | 1N4895 | 0.086 | 1N4897 | 0.048 | 1N4898 | 0.019 | 1N4899 | 0.010 | | |
| | 0.5 | A | 1N4895A | 0.198 | 1N4897A | 0.099 | 1N4898A | 0.040 | 1N4899A | 0.020 | | |
| | 1.0 | G | 1N4900 | 0.096 | 1N4901 | 0.048 | 1N4902 | 0.019 | 1N4903 | 0.010 | | |
| | 1.0 | A | 1N4900A | 0.198 | 1N4901A | 0.099 | 1N4902A | 0.040 | 1N4903A | 0.020 | | |
| | 2.0 | G | 1N4904 | 0.096 | 1N4905 | 0.048 | 1N4906 | 0.019 | 1N4907 | 0.010 | | |
| | 2.0 | A | 1N4904A | 0.198 | 1N4905A | 0.099 | 1N4906A | 0.040 | 1N4907A | 0.020 | | |
| | 4.0 | G | 1N4908 | 0.096 | 1N4909 | 0.048 | 1N4910 | 0.019 | 1N4911 | 0.010 | | |
| | 4.0 | A | 1N4908A | 0.198 | 1N4909A | 0.099 | 1N4910A | 0.040 | 1N4911A | 0.020 | | |
| | 7.5 | G | 1N4912 | 0.096 | 1N4913 | 0.048 | 1N4914 | 0.019 | 1N4915 | 0.010 | | |
| | 7.5 | A | 1N4912A | 0.198 | 1N4913A | 0.099 | 1N4914A | 0.040 | 1N4915A | 0.020 | | |
| 1.9 | 0.5 | G | 1N4915 | 0.144 | 1N4917 | 0.072 | 1N4918 | 0.029 | | | | |
| | 0.5 | A | 1N4915A | 0.298 | 1N4917A | 0.149 | 1N4918A | 0.060 | | | | |
| | 1.0 | G | 1N4919 | 0.144 | 1N4920 | 0.072 | 1N4921 | 0.029 | | | | |
| | 1.0 | A | 1N4919A | 0.298 | 1N4920A | 0.149 | 1N4921A | 0.060 | | | | |
| | 2.0 | G | 1N4922 | 0.144 | 1N4923 | 0.072 | 1N4924 | 0.029 | | | | |
| | 2.0 | A | 1N4922A | 0.298 | 1N4923A | 0.149 | 1N4924A | 0.060 | | | | |
| | 4.0 | G | 1N4925 | 0.144 | 1N4926 | 0.072 | 1N4927 | 0.029 | 1N4928 | 0.014 | | |
| | 4.0 | A | 1N4925A | 0.298 | 1N4926A | 0.149 | 1N4927A | 0.060 | 1N4928A | 0.030 | | |
| | 7.5 | G | 1N4928 | 0.144 | 1N4930 | 0.072 | 1N4931 | 0.029 | 1N4932 | 0.014 | | |
| | 7.5 | A | 1N4928A | 0.298 | 1N4930A | 0.149 | 1N4931A | 0.060 | 1N4932A | 0.030 | | |

Test Temperature Points

| | |
|---|------------------------------|
| A | -55, 0, +25, +75, +100 |
| B | 0, +25, +75 |
| C | -55, 0, +25, +75, +100, +150 |
| D | 0, +25, +70 |
| E | -55, 0, +125, +75, +125 |
| F | -55, 0, +75, +125, +185 |
| G | +25, +75, +100 |



Non-suffix — $Z_{T1} = 15$, "A" Suffix — $Z_{T1} = 10$
 * Radiation Resistant Devices Available; to order,
 specify MZB21, A or B in lieu of "1N" prefix.
 Not applicable to J or TX devices.

SPECIAL DEVICES (continued)



High-Voltage Devices consist of hermetically sealed discrete glass-packaged devices, properly interconnected to yield higher voltages and encapsulated in a transfer-molded plastic package. Includes JAN devices. All devices encapsulated in Case 41, exceptions shown.

CASE 41 — EXCEPT AS NOTED

| Reference Voltage V _Z Volts | Test Current I _{ZT} mA | Max Voltage Change V _Z (Volts) @ Test Temperatures -55 to +25°C +25 to 100°C | | Average Temp. Coeff. %/°C | Device Type |
|--|---------------------------------------|---|----------------|---------------------------------|-----------------------|
| 6.2 | 7.5 | 0.050 (1) 0.050 (1) | | 0.01 0.01 | 1N429 (2) 1N1735 |
| 8.4 | 10 | 0.014 (1) 0.007 | | 0.002 0.001 | 1N1530 1N1530A (2) |
| 12.4 | 7.5 | 0.100 (1) 0.050 | | 0.01 0.005 | 1N1736 1N1736A |
| 12.4 | 10 | 0.050 0.020 | 0.047 0.010 | 0.005 0.002 | 1N4057 1N4057A |
| 14.6 | ↓ | 0.058 0.023 | 0.055 0.022 | 0.005 0.002 | 1N4058 1N4058A |
| 15.8 | | 0.067 0.027 | 0.063 0.025 | 0.005 0.002 | 1N4059 1N4059A |
| 18.5 | | 0.074 0.030 | 0.069 0.028 | 0.005 0.002 | 1N4060 1N4060A |
| 18.6 | 7.5 | 0.150 (1) 0.075 | | 0.01 0.005 | 1N1737 1N1737A |
| 21 | 10 | 0.084 0.034 | 0.079 0.032 | 0.005 0.002 | 1N4061 1N4061A |
| 23 | 10 | 0.092 0.037 | 0.086 0.035 | 0.005 0.002 | 1N4062 1N4062A |
| 24.8 | 7.5 | 0.200 (1) 0.100 | | 0.01 0.005 | 1N1738 1N1738A |
| 27 | 10 | 0.108 0.043 | 0.101 0.041 | 0.005 0.002 | 1N4063 1N4063A |
| 30 | 10 | 0.120 0.048 | 0.113 0.045 | 0.005 0.002 | 1N4064 1N4064A |
| 31.0 | 7.5 | 0.250 (1) 0.125 | | 0.01 0.005 | 1N1739 1N1739A |
| 33 | 10 | 0.132 0.053 | 0.124 0.050 | 0.005 0.002 | 1N4065 1N4065A |
| 37 | ↓ | 0.148 0.059 | 0.139 0.056 | 0.005 0.002 | 1N4066 1N4066A |
| 37.2 | | 0.300 (1) 0.150 | | 0.01 0.005 | 1N1740 1N1740A |
| 43 | | 0.172 0.059 | 0.161 0.065 | 0.005 0.002 | 1N4067 1N4067A |
| 43.4 | ↓ | 0.350 (1) 0.175 | | 0.01 0.005 | 1N1741A 1N1741A |

| Reference Voltage V _Z Volts | Test Current I _{ZT} mA | Max Voltage Change V _Z (Volts) @ Test Temperatures -55 to +25°C +25 to 100°C | | Average Temp. Coeff. %/°C | Device Type |
|--|---------------------------------------|---|----------------|---------------------------------|-------------------|
| 47 | 7.5 | 0.188 0.075 | 0.176 0.071 | 0.005 0.002 | 1N4068 1N4068A |
| 49.6 | | 0.400 (1) 0.200 | | 0.01 0.005 | 1N1742 1N1742A |
| 51 | | 0.204 0.082 | 0.191 0.077 | 0.005 0.002 | 1N4069 1N4069A |
| 56 | ↓ | 0.224 0.090 | 0.210 0.084 | 0.005 0.002 | 1N4070 1N4070A |
| 62 | | 0.248 0.099 | 0.232 0.093 | 0.005 0.002 | 1N4071 1N4071A |
| 68 | | 0.272 0.109 | 0.255 0.102 | 0.005 0.002 | 1N4072 1N4072A |
| 75 | 5.0 | 0.300 0.120 | 0.281 0.113 | 0.005 0.002 | 1N4073 1N4073A |
| 82 | | 0.328 0.131 | 0.307 0.123 | 0.005 0.002 | 1N4074 1N4074A |
| 87 | | 0.348 0.139 | 0.325 0.131 | 0.005 0.002 | 1N4075 1N4075A |
| 91 | ↓ | 0.364 0.145 | 0.341 0.137 | 0.005 0.002 | 1N4076 1N4076A |
| 100 | | 0.400 0.150 | 0.375 0.150 | 0.005 0.002 | 1N4077 1N4077A |
| 105 | | 0.420 0.168 | 0.394 0.158 | 0.005 0.002 | 1N4078 1N4078A |
| 110 | 2.5 | 0.440 0.175 | 0.413 0.165 | 0.005 0.002 | 1N4079 1N4079A |
| 120 | | 0.480 0.192 | 0.450 0.180 | 0.005 0.002 | 1N4080 1N4080A |
| 130 | | 0.520 0.208 | 0.488 0.195 | 0.005 0.002 | 1N4081 1N4081A |
| 140 | ↓ | 0.560 0.224 | 0.525 0.210 | 0.005 0.002 | 1N4082 1N4082A |
| 150 | | 0.600 0.240 | 0.563 0.225 | 0.005 0.002 | 1N4083 1N4083A |
| 175 | | 0.700 0.280 | 0.656 0.263 | 0.005 0.002 | 1N4084 1N4084A |
| 200 | ↓ | 0.800 0.320 | 0.750 0.300 | 0.005 0.002 | 1N4085 1N4085A |

(1) These devices are tested at the following temperatures: -55°, +25°, and +100°C.
(2) Available as JAN devices.

SPECIAL DEVICES

Precision Reference Diodes. Designed, manufactured and tested for ultra-high stability of voltage with time and temperature change. Use of special measurement equipment and voltage standards provide calibration directly traceable to the National Bureau of Standards.


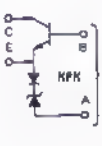
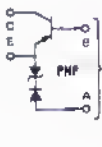

CASE 51

| Reference Voltage Volts | Test Current mA | Temperature Stability | | CERTIFIED VOLTAGE TIME STABILITY OVER 1000 HOURS OF OPERATION (Parts/Million Change) | | | | | | | | | |
|-------------------------|-----------------|-----------------------|------------------|--|--------------------|-----------------|--------------------|-----------------|--------------------|-----------------|--------------------|------------------|--------------------|
| | | ΔV_Z (mV) | OP Temp Range °C | <5 PPM/1000 HR | | <10 PPM/1000 HR | | <20 PPM/1000 HR | | <40 PPM/1000 HR | | <100 PPM/1000 HR | |
| | | | | Device Type | Change μV Max | Device Type | Change μV Max | Device Type | Change μV Max | Device Type | Change μV Max | Device Type | Change μV Max |
| 6.2 \pm 5% | 7.5 | 2.5 | 25, 75, 100 | MZ605 | 20 | MZ610 | 60 | MZ620 | 120 | MZ640 | 240 | | |
| 8.4 \pm 5% | 10 | 3.5 | 25, 75, 100 | MZ805 | 45 | MZ810 | 90 | MZ820 | 180 | MZ840 | 360 | | |
| 8.25 \pm 6% | 7.5 | 2.5 | 25 to 100 | | | 1N4895 | 64 | 1N4893 | 127 | | | 1N4891* | 318 |
| 6.25 \pm 5% | 7.5 | 5.0 | -55 to 100 | | | 1N4896A | 64 | 1N4893A | 127 | | | 1N4891A* | 218 |
| 6.35 \pm 5% | 7.5 | 5.0 | 25 to 100 | | | 1N4894A | 64 | 1N4892A | 127 | | | 1N4890* | 218 |
| 6.35 \pm 6% | 7.5 | 10 | -55 to 100 | | | | | | | | | 1N4890A* | 218 |
| 8.2 - 8.6 | 7.5 | 3.0 | 25 to 100 | | | | | | | | | 1N3502 | 638 |
| 8.2 - 8.6 | 7.5 | 6.0 | 25 to 100 | | | | | 1N3504 | 127 | 1N3503 | 318 | 1N2501 | 836 |


* < 50 PPM time stability on these devices.

Amplifying Regulator Diodes. Designed for use in regulated power supplies as a combination voltage reference element and error voltage amplifier, providing temperature compensation for excellent reference voltage stability. Available with either PNP or NPN transistors by adding either P or N Suffix to part number.

ELECTRICAL CHARACTERISTICS ($I_{ZT} = 5.0 \text{ mA}$, $V_{CEO} = 30 \text{ V}$)

|  | V_{REF} Volts | Tolerance $\pm\%$ | Test Temperature °C | V_{REF} Volts | Device Type |
|---|-----------------|-------------------|--------------------------------|----------------------------------|--|
| | | | | | |
|  | 6.8 | 10 | 0, +25, +75 | 0.051 0.075 0.010 0.005 | MCA1911 MCA1912 MCA1913 MCA1914 |
| | 6.8 | 5.0 | -55, 0, +25 -55, -100 | 0.105 0.052 0.020 0.010 | MCA1921 MCA1822 MCA1923 MCA1924 |
| | 6.8 | 5.0 | -65, 0, +25 +75, +100, +150 | 0.129 0.069 0.026 0.013 | MCA1931 MCA1822 MCA1933 MCA1934 |
| | 8.6 | 10 | 0, +25, +75 | 0.060 0.030 0.012 0.005 | MCA2011 MCA2012 MCA2014 MCA2014 |
|  | 8.6 | 5.0 | -55, 0, +25 +75, -100 | 0.124 0.062 0.024 0.012 | MCA2021 MCA2022 MCA2023 MCA2024 |
| | 8.6 | 5.0 | -55, 0, +25 +75, +100, +150 | 0.164 0.082 0.032 0.016 | MCA2021 MCA2022 MCA2033 MCA2034 |
| | 9.5 | 10 | 0, +25, +75 | 0.071 0.038 0.014 0.007 | MCA2111 MCA2112 MCA2112 MCA2114 |
| | 9.5 | 5.0 | -55, 0, +25 +75, +100 | 0.147 0.073 0.028 0.014 | MCA2121 MCA2122 MCA2122 MCA2124 |
|  | 9.5 | 5.0 | -55, 0, +25 +75, -100, +150 | 0.194 0.097 0.038 0.019 | MCA2121 MCA2122 MCA2122 MCA2134 |
| | 11 | 10 | 0, +25, +75 | 0.082 0.041 0.018 0.008 | MCA2211 MCA2212 MCA2213 MCA2214 |
| | 11 | 5.0 | -55, 0, +25 +75, +100 | 0.170 0.085 0.034 0.017 | MCA2221 MCA2222 MCA2223 MCA2224 |
| | 11 | 5.0 | -55, 0, +25 +75, +100, +150 | 0.225 0.112 0.044 0.022 | MCA2221 MCA2232 MCA2233 MCA2234 |

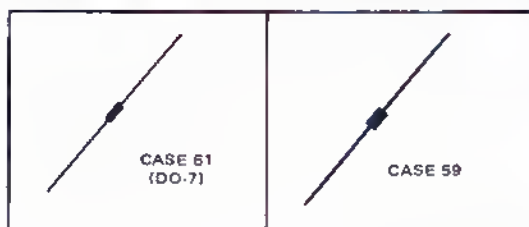
Field-Effect Current Regulator Diodes. High impedance diodes providing a constant current output over a wide range of applied voltages. For applications in instrumentation and protective circuitry.

| | |  Glass Case 61 DO-7 | |
|--|----------------|---|--|
| Reg. Current I_p @ $V_T = 25 \text{ V}$ mA Nom | Device Type | Knee Imp Z_K @ $V_K = 6.0 \text{ V}$ M Ω Max | Limiting Voltage @ $I_L = 0.8 I_p$ Volts Max |
| 0.22 | 1N5283 | 2.75 | 1.00 |
| 0.24 | 1N5284 | 2.35 | 1.00 |
| 0.27 | 1N5285 | 1.95 | 1.00 |
| 0.30 | 1N5286 | 1.60 | 1.00 |
| 0.32 | 1N5287 | 1.35 | 1.00 |
| 0.39 | 1N5288 | 1.00 | 1.05 |
| 0.43 | 1N5289 | 0.870 | 1.05 |
| 0.47 | 1N5290 | 0.750 | 1.05 |
| 0.56 | 1N5291 | 0.560 | 1.10 |
| 0.62 | 1N5292 | 0.470 | 1.12 |
| 0.68 | 1N5293 | 0.400 | 1.15 |
| 0.76 | 1N5294 | 0.225 | 1.20 |
| 0.82 | 1N5295 | 0.290 | 1.25 |
| 0.91 | 1N5296 | 0.240 | 1.28 |
| 1.00 | 1N5297 | 0.205 | 1.35 |
| 1.10 | 1N5298 | 0.180 | 1.40 |
| 1.20 | 1N5299 | 0.155 | 1.45 |
| 1.20 | 1N5300 | 0.135 | 1.50 |
| 1.40 | 1N5301 | 0.115 | 1.55 |
| 1.50 | 1N5302 | 0.105 | 1.60 |
| 1.60 | 1N5303 | 0.092 | 1.65 |
| 1.80 | 1N5304 | 0.074 | 1.75 |
| 2.00 | 1N5305 | 0.061 | 1.85 |
| 2.20 | 1N5306 | 0.052 | 1.95 |
| 2.40 | 1N5307 | 0.044 | 2.00 |
| 2.70 | 1N6208 | 0.025 | 2.15 |
| 3.00 | 1N5209 | 0.029 | 2.25 |
| 3.30 | 1N5310 | 0.024 | 3.25 |
| 3.80 | 1N5311 | 0.020 | 2.50 |
| 3.90 | 1N5312 | 0.017 | 2.50 |
| 4.20 | 1N5313 | 0.014 | 2.75 |
| 4.70 | 1N5314 | 0.012 | 2.90 |
| 0.5:0.2 | MCL1300 | 0.500 | 1.00 |
| 1.0:0.6 | MCL1301 | 0.200 | 1.50 |
| 2.0:0.6 | MCL1202 | 0.100 | 2.00 |
| 2.0:0.6 | MCL1303 | 0.050 | 2.00 |
| 4.0:0.6 | MCL1304 | 0.025 | 2.50 |

SPECIAL DEVICES (continued)

Low Voltage Regulators

High-conductance silicon diodes designed as stable forward-reference sources for transistor amplifier biasing and similar applications. Available in high reliability glass construction or economic plastic packaging.



ELECTRICAL CHARACTERISTICS

($T_A = 25^\circ\text{C}$ unless otherwise noted).

| Forward Reference Voltage | | Test Current I_F mA | Leakage Current I_R @ V_R μA Volts | | Device Type | Case |
|---------------------------|------|--------------------------|---|-----|-------------|----------------|
| Min | Max | | | | | |
| 0.63 | 0.71 | 10 | 10 | 5.0 | MZ2360 | 59 |
| 1.24 | 1.38 | 10 | 10 | 5.0 | MZ2361 | Surmetic 51 |
| 1.90 | 2.10 | 10 | 10 | 6.0 | MZ2362 | Surmetic 61 |
| 0.58 | 0.70 | 1.0 | 0.1 | 4.0 | .4M.64FR10 | Glass |
| 1.29 | 1.43 | 10 | | | .4M1.36FR5 | |
| 1.33 | 1.39 | 10 | | | .4M1.36FR2 | |
| 1.94 | 2.14 | 10 | | | .4M2.04FR5 | |
| 2.00 | 2.08 | 10 | | | .4M2.04FR2 | |
| 0.58 | 0.70 | 1.0 | | | 1N816 | |

Current Limited Temperature Compensated Voltage Reference Diodes

Voltage reference element with inherent temperature compensation and current regulation resulting in excellent reference stability over temperature excursions and wide variations of input voltage.

Specifications in the following table are given for an input of 31 volts. Devices differ specifically in temperature as shown in ΔV_{REF} .

| V_{REF} @ $V_{in} = 31$ Volts | | V_{in} Volts | | I_{in} @ $V_{in} = 31$ Volts | | Input Impedance $M\Omega$ Min | Z_{REF} @ $I_{in} = 4.0$ mA Ohms Max | ΔV_{REF} @ $V_{in} = 31$ Volts $-55^\circ\text{C}, +25^\circ\text{C}, +100^\circ\text{C}$ | | Device Type |
|---------------------------------------|------|-------------------|-----|--------------------------------------|-----|--|--|---|--|----------------|
| Min | Max | Min | Max | Min | Max | | | Volts Max | | |
| 6.08 | 6.72 | 12 | 75 | 3.2 | 4.8 | 0.2 | 50 | 0.010 | | MCLTC6010 |
| 6.08 | 6.72 | 12 | 75 | 3.2 | 4.8 | 0.2 | 50 | 0.025 | | MCLTC6025 |
| 6.08 | 6.72 | 12 | 75 | 3.2 | 4.8 | 0.2 | 50 | 0.050 | | MCLTC6050 |
| 6.08 | 6.72 | 12 | 75 | 3.2 | 4.8 | 0.2 | 50 | 0.100 | | MCLTC6100 |



CASE 181-02

Tuning Diode Regulator

Highly reliable temperature compensated monolithic integrated circuit voltage stabilizer designed for use in television and FM radios that use variable capacitance diode tuners.

| V_Z Volts Min/Max | I_Z mA | ΔV_Z ΔT mV/ $^\circ\text{C}$ Min/Max | Z_Z Ohms Max | P_D mW | Device Type |
|---------------------------|-------------|---|----------------------|-------------|----------------|
| 31/35 | 18 | -31/+1.65 | 25 | 628 | MVS460 |



CASE 182-01

Dual Diodes

Dual diodes designed for use in low cost biasing, steering and voltage doubler applications including series, common cathode and common anode diodes.

| $V_{(BR)}$ @ $I_{(BR)}$ Volts Min | | I_R @ V_R μA Max | | V_F @ Volts Min/Max | | I_F mA | $C_{VR} = 0$ pF Max | t_{rr} ns Max | Device Type | Description |
|---|-----|---------------------------------------|----|-----------------------------|----|-------------|---------------------------|-----------------------|----------------|----------------|
| 100 | 100 | 0.1 | 50 | 0.67/0.82 | 10 | 1.6 | 4.0 | 4.0 | MSD6100 | Switching |
| 50 | 100 | 0.1 | 40 | 0.67/0.82 | 10 | 2.0 | 10 | 10 | MSD6101 | Discriminator |
| 70 | 100 | 0.1 | 50 | 0.67/1.0 | 10 | 3.0 | 100 | 100 | MSD6102 | Common Cathode |
| 70 | 100 | 0.1 | 50 | -1/1.0 | 10 | 8.0 | 100 | 100 | MSD6160 | Common Cathode |
| 100 | 100 | 0.2 | 50 | 0.67/0.82 | 10 | 1.6 | 16 | 16 | MSD7000 | Series |



CASE 29
(TO-92)

TRANSIENT SUPPRESSORS

POWER TRANSIENT SUPPRESSORS

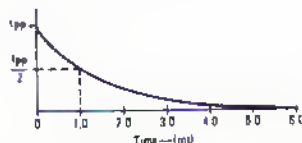
Transient suppressors designed for applications requiring protection of voltage sensitive electronic devices in danger of destruction by high energy voltage transients. Select from standard factory available types or design the suppressor to meet specific needs by paralleling cells. For specific options, i.e., non-standard voltages, higher power capacity, and package configurations, consult factory.



CASE 60-02




CASE 119



| V _R Operating Voltage | | I _R Reverse Current μA | V _Z Breakdown Voltage @ | | V _Z Clamping Voltage @ | | V _F Forward Voltage @ | | Device Type | Case |
|-------------------------------------|--------|--|--|-----------------------|---|------------------------|--|-----------------------|-------------|-------|
| Nom Vdc | V(RMS) | | Min Volts | I _{ZT} mA | Max Volts | I _{pp} Amp | Volts | I _F Amp | | |
| 14 | 10 | 50 | 16 | 0.4 | 1.25 | | 1.5 | 10 | MPZ5-16A | 119 |
| 14 | 10 | | 16 | 0.4 | 1.25 | | | | MPZ5-16B | |
| 28 | 20 | | 32 | 0.2 | 1.25 | | | | MPZ6-32A | |
| 28 | 20 | | 32 | 0.2 | 1.25 | | | | MPZ6-32B | |
| 28 | 20 | | 32 | 0.2 | 1.25 | | | | MPZ5-32C | |
| 165 | 117 | | 180 | 0.03 | 1.14 | | | | MPZ6-180A | |
| 165 | 117 | 5.0 | 180 | 0.03 | 1.14 | | | | MPZ5-180B | 60-02 |
| 165 | 117 | | 180 | 0.03 | 1.14 | | | | MPZ6-180C | |
| 30.5 | 21.6 | | 33 | 1.0 | 47.6 | 32 | 2.0 | 100 | MZ5555 | |
| 40.3 | 28.5 | | 43.7 | | 63.5 | 24 | 2.5 | | MZ5556 | |
| 49 | 34.5 | | 64 | | 78.5 | 19 | 2.8 | | MZ5557 | |
| 175 | 124 | | 191 | | 265 | 5.7 | 3.5 | | MZ5558 | |

Power Rectifier/Power Surge Suppressor

... designed for applications requiring a low voltage rectifier with reverse avalanche characteristics or for use as a reverse power transient suppressor. Developed to suppress transients in the automotive system, this device operates in the forward mode as a standard rectifier or reverse mode as a power zener diode and will protect expensive mobile transceivers, radios and tape decks from over-voltage conditions.

|  | B _V Breakdown Voltage @ I _R = 100 mA Volts | I _R Reverse Current @ V _R = 20 V Max μA | V _F Instantaneous Forward Voltage @ I _F = 79A Volts | I _(RMS) Forward Current Max Amp | Device Type |
|---|---|--|---|---|-------------|
| | 32 | 50 | 1.1 | 94 | MR2525,R |

CASE 296-03

Polarity: Standard polarity is cathode to case — MR2525
Reverse polarity is anode to case and is designated by an
"R" suffix — MR2525R



RECTIFIERS

From tiny, lead-mounted, low-current rectifiers to powerful multi-cell units with near-thousand-amp capacity; from single-phase, half-wave devices to three-phase circuits; from conventional diode junctions to special-purpose units for specific applications, Motorola's extensive line of rectifiers satisfies every possible requirement for electronic equipment. Moreover, volume production unmatched in the industry offers low-cost selection potential.

TABLE OF CONTENTS

| | Page |
|--|------|
| General Purpose Rectifiers | |
| <u>Low and Medium Current</u> | 4-87 |
| Single-cell rectifiers with forward current ranging from 1A to 50A and reverse voltage ratings up to 1000 volts. | |
| <u>High Current</u> | 4-88 |
| Multi-cell devices with up to 700 A/600 V off-the-shelf ratings and even greater current and voltage capability on a custom basis. | |
| Rectifier Bridges and Circuits | |
| <u>Low-to-Medium Current</u> | 4-89 |
| A variety of packaging methods yields current ratings up to 30 A and reverse-voltage ratings to 1000 V. | |
| <u>High Current</u> | 4-90 |
| Single-phase and three-phase bridges and circuits with current ratings up to 650 A. | |
| Special Purpose Rectifiers | |
| <u>Fast Recovery Devices</u> | 4-91 |
| For circuit applications requiring switching times from 200 to 1000 nano-seconds. Current rating up to 50 A. | |
| <u>Hot Carrier Devices</u> | 4-92 |
| For high-frequency power supplies demanding switching times of less than 10 nano-seconds. | |

The following index reflects the devices characterized in this section. To locate the exact page number, see Catalog Index (Page 7-1).

INDEX

| | | |
|-----------------|-----------|----------|
| 1N2488 | 1N5830 | MR752 |
| 1N2498 | 1N5832 | MR764 |
| 1N2508 | 1N5833 | MR766 |
| 1N1183 | BYW00 | MR800 |
| 1N1183A | BYW61 | MR801 |
| 1N1184 | BYW62 | MR802 |
| 1N1184A | BYW64 | MR804 |
| 1N1186 | BYW66 | MR806 |
| 1N1186A | BYW68 | MR810 |
| 1N1188 | | MR811 |
| 1N1188A | MR81520 | MR812 |
| 1N1190 | MR82520 | MR814 |
| 1N1190A | MR82530 | MR810 |
| 1N1191 | MR84020PF | MR817 |
| 1N1192 | MR84030 | MR818 |
| 1N1194 | MR84030PF | |
| 1N1190A | MDA100 | MR820 |
| 1N1188A | MDA101 | MR821 |
| 1N1199A | MDA102 | MR822 |
| 1N1200A | MDA104 | MR824 |
| 1N1204A | MDA106 | MR826 |
| 1N1200A | MDA108 | MR830 |
| 1N3208 | MDA110 | MR831 |
| 1N3209 | MDA800 | MR832 |
| 1N3210 | MDA801 | MR834 |
| 1N3212 | MDA802 | MR836 |
| 1N3214 | MDA804 | |
| 1N3491 | MDA806 | MR850 |
| 1N3482 | MDA920A2 | MR851 |
| 1N3493 | MDA920A3 | MR852 |
| 1N3495 | MDA920A4 | MR854 |
| 1N3659 | MDA920A0 | MR856 |
| 1N3660 | MDA920A7 | MR800 |
| 1N3601 | MDA922-2 | MR801 |
| 1N3003 | MDA922-3 | MR802 |
| 1N3879 | MDA922-0 | MR804 |
| 1N3580 | MDA922-7 | MR806 |
| 1N3881 | MDA922-8 | MR870 |
| 1N3883 | MDA922-9 | MR871 |
| 1N3889 | MDA942-1 | MR872 |
| 1N3890 JAN, JTX | MDA942-2 | MR874 |
| 1N3891 JAN, JTX | MDA942-3 | MR876 |
| 1N3893 JAN, JTX | MDA942-5 | MR1-1000 |
| 1N3898 | MDA942-6 | MR1-1200 |
| 1N3900 | MDA970-1 | MR1-1400 |
| 1N3901 | MDA970-2 | MR1-1000 |
| 1N3903 | MDA970-3 | MR1120 |
| 1N3909 | MDA970-5 | MR1121 |
| 1N3810 JAN, JTX | MDA980-1 | MR1122 |
| 1N3911 JAN, JTX | MDA980-2 | MR1124 |
| 1N3913 JAN, JTX | MDA980-3 | MR1120 |
| 1N3988 | MDA980-5 | MR1128 |
| 1N3990 | MDA980-6 | MR1130 |
| 1N4001 | MDA990-1 | MR1368 |
| 1N4002 | MDA990-2 | MR1378 |
| 1N4003 | MDA990-3 | MR1360 |
| 1N4004 | MDA990-5 | MR1390 |
| 1N4005 | MDA990-6 | MR2000S |
| 1N4006 | MDA1200 | MR2001S |
| 1N4007 | MDA1201 | MR2002S |
| 1N4719 | MDA1202 | MR2004S |
| 1N4720 | MDA1204 | MR2006S |
| 1N4721 | MDA6893 | MR2008S |
| 1N4722 | MDA1206 | MR2008S |
| 1N4723 | MDA3500 | MR2010S |
| 1N4724 | MDA3501 | MR2500 |
| 1N4725 | MDA3502 | MR2500S |
| 1N4933 | MDA3504 | MR2501 |
| 1N4934 | MDA3506 | MR2501S |
| 1N4935 | MDA3510 | MR2502 |
| 1N4938 | MDA0693 | MR2502S |
| 1N4837 | MR250-1 | MR2504S |
| 1N4987 | MR250-2 | MR2506 |
| 1N4998 | MR250-3 | MR2508 |
| 1N4999 | MR250-4 | MR2508S |
| 1N5000 | MR250-5 | MR2510 |
| 1N5001 | MR328 | MR2510S |
| 1N5002 | MR330 | MR2510S |
| 1N5003 | MR331 | MR2510S |
| 1N5817 | MR500 | MR2510S |
| 1N5818 | MR501 | MR2510S |
| 1N5820 | MR502 | MR2510S |
| 1N5821 | MR504 | MR2510S |
| 1N5823 | MR506 | MR2510S |
| 1N5824 | MR508 | MR2510S |
| 1N5826 | MR510 | MR2510S |
| 1N5827 | MR750 | MR2510S |
| 1N5829 | MR751 | MR2510S |

| | 1.0 | 3.0 | 6.0 | |
|--|---------------|----------|----------|-------------|
| Case | 59-04 Plastic | 60 Metal | 70 Metal | 267 Plastic |
| V _{RRM} Volts | 194 Plastic | | | |
| 50 | 1N4001† | 1N4719 | 1N4997 | MR500 |
| 100 | 1N4002† | 1N4720 | 1N4998 | MR501 |
| 200 | 1N4003† | 1N4721 | 1N4999 | MR502 |
| 400 | 1N4004† | 1N4722 | 1N5000 | MR504 |
| 600 | 1N4005† | 1N4723 | 1N5001 | MR506 |
| 800 | 1N4006† | 1N4724 | 1N5002 | MR508 |
| 1000 | 1N4007† | 1N4725 | 1N5003 | MR510 |
| I _{FSM} (Amps) | 30 | 300 | 300 | 100 |
| T _A @ Rated I _O (°C) | 75 | 75 | 75 | 95 |
| T _C @ Rated I _O (°C) | | | | |
| T _J (Max) (°C) | 175 | 175 | 175 | 175 |












† Package Size: 0.120" Max Diameter by 0.260" Max. Length

GENERAL PURPOSE RECTIFIERS

Low and Medium Current

Wide variety of low-cost devices to fit any mounting requirements.







These lines are also available with anode-to-case connection by adding "R" suffix to the standard part number.

| 10 AVERAGE RECTIFIED FORWARD CURRENT (Amperes) | | | | | | | | | | |
|--|--|--|--|--|--|--|--|--|---|--|
| 12 | 15 | 20 | | 25 | | 30 | 35 | 40 | 50 | |
| 245 (DO-4) Metal | 42A (DO-5) Metal | 42A (DO-5) Metal | 283-01 (DO-4) Low-Cost Plastic | 283-01 (DO-4) Low-Cost Plastic | 193-03 Low-Cost Plastic | 43 (DO-21) Pressfit | 43 (DO-21) Metal | 42A (DO-5) Metal | 42A (DO-5) Metal | 43-04 Metal |
|  |  |  |  |  |  |  |  |  |  |  |
| MR1120 1N1199,A | 1N3208 | 1N248B 1N1191 | MR2000S | MR2500S | MR2500 | 1N3491 | 1N3659 | 1N1183 | 1N1183A | MR5005 |
| MR1121 1N1200,A | 1N3209 | 1N249B 1N1192 | MR2001S | MR2501S | MR2501 | 1N3492 | 1N3660 | 1N1184 | 1N1184A | MR5010 |
| MR1122 1N1202,A | 1N3210 | 1N250B 1N1194 | MR2002A | MR2502S | MR2502 | 1N3493 | 1N3661 | 1N1186 | 1N1186A | MR5020 |
| MR1124 1N1204,A | 1N3212 | 1N1196 1N1196A | MR2004S | MR2504S | MR2504 | 1N3495 | 1N3663 | 1N1188 | 1N1188A | MR5040 |
| MR1126 1N1206A | 1N3214 | 1N1198A 1N3214 | MR2006S | MR2506S | MR2506 | MR328 | | 1N1190 | 1N1190A | |
| MR1128 1N3988 | | | MR2008S | MR2508S | MR2508 | MR330 | | | | |
| MR1130 1N3990 | | | MR2010S | MR2510S | MR2510 | MR331 | | | | |
| 300 | 250 | 350 | 400 | 600 | 400 | 30 | 400 | 400 | 800 | 600 |
| | | | | | | | | | | |
| 150 | 150 | 150 | 150 | 150 | 150 | 130 | 100 | 140 | 150 | 150 |
| 190 | 175 | | | | | 175 | 175 | 190 | 190 | 195 |

▲ Request Data Sheet for Mounting Information

High-Current Multi-Cell Rectifier Diodes











Multi-Cell construction, with matched cells, for excellent thermal management and highest reliability. Normally available with cathode connected to case. Add "R" suffix to type number for reverse polarity.

| | I _O , AVERAGE RECTIFIED FORWARD CURRENT | | | | |
|---|---|---|---|--|--|
| | 50A | 100A | | 450A | 700A |
| |  Case 100 |  Case 167 |  Case 189 |  Case 128  Case 135 |  Case 136 |
| V _{RRM} (Volts) | | | | | |
| 300 | MR1205FL | MR1215FL | MR1815SL | MR1245SL,FL | MR1265FL |
| 600 | MR1209FL | MR1219SL | MR1819SL | MR1249SL,FL | MR1269FL |
| I _{FSM} (Amp) | 800 | 2000 | 2000 | 8000 | 1200 |
| T _C @ Rated I _O (°C) | 150 | 135 | 135 | 150 | 150 |
| T _J (Max) (°C) | 190 | 190 | 190 | 190 | 190 |

RECTIFIER BRIDGES and CIRCUITS

Low -To-Medium Current

Single-phase rectifier bridges with a wide variety of packaging options. Standard devices are made with general-purpose rectifiers, but similar configurations can be made with special rectifier-cells (i.e., fast recovery cells) on special order.

















| I _O , DC OUTPUT CURRENT (Amperes) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1.0 | 1.0 | 2.0 | 4.0 | 8.0 | 12 | 30 | 35 | | |
| Case | 109 (1) | 312-01 (1) | 312-01 | 117 (1) | 298-01 (2) | 117 | 298-01 (2) | 179-01 (1) | 179-02 (1) | 309 |
| V _{RRM} Volts |  |  |  |  |  |  |  |  |  |  |
| 50 | MDA920A2 | MDA100A | MDA200 | MDA970-1 | MDA800 | MDA970-1 | MDA1200 | MDA980-1 | MDA990-1 | MDA3500 BYW60 |
| 100 | MDA920A3 | MDA101A | MDA201 | MDA970-2 | MDA801 | MDA970-2 | MDA1201 | MDA980-2 | MDA990-2 | MDA3501 BYW61 |
| 200 | MDA920A4 | MDA102A | MDA202 | MDA970-3 | MDA802 | MDA970-3 | MDA1202 | MDA980-3 | MDA990-3 | MDA3502 BYW62 |
| 400 | MDA920A6 | MDA104A | MDA204 | MDA970-5 | MDA804 | MDA970-5 | MDA1204 | MDA980-5 | MDA990-5 | MDA3504 BYW64 |
| 600 | MDA920A7 | MDA106A | MDA206 | | MDA806 | | MDA1206 | MDA980-6 | MDA990-5 | MDA3506 BYW66 |
| 800 | | MDA108A | MDA208 | | | | | | | MDA3508 BYW68 |
| 1000 | | MDA110A | MDA210 | | | | | | | MDA3510 |
| I _{FSM} Amp | 32 | 45 | 60 | 100 | 300 | 100 | 300 | 300 | 300 | 400 |
| T _A @ Rated I _O (°C) | 75 | 55 | 55 | 25 | | | | | | |
| T _C @ Rated I _O (°C) | | | | | 100 | 55 | 100 | 55 | 55 | 55 |
| T _J (Max) (°C) | 175 | 150 | 175 | 150 | 175 | 150 | 175 | 175 | 175 | 175 |

(1) Lead Frame Assembly

(2) Discrete Diode Assembly Utilizing Metal Cased Rectifiers

High-Current Multi-Cell Rectifier Circuits

Multi-cell full-wave rectifier circuits and bridges with up to 650 A current carrying capacity.

| I _O , AVERAGE RECTIFIER FORWARD CURRENT (Forced Convection at 1500 LFM) | | | | | | | | |
|--|---|---|--|--|---|---|---|--|
| Circuit | 300 A | | | | 600 A | | 650 A | |
| | Single-Phase Full-Wave Center Tap | Single-Phase Full-Wave Bridge | Three-Phase Full-Wave Center Tap | Three-Phase Full-Wave Bridge | Single-Phase Full-Wave Center Tap | Single-Phase Full-Wave Bridge | Three-Phase Full-Wave Center Tap | Three-Phase Full-Wave Bridge |
| Waveforms |  |  |  |  |  |  |  |  |
| Case VRRM (Volts) | 154A  | 155A  | 154  | 155  | 158A  | 157A  | 156  | 157  |
| 300 | MRA133 | MRA133B | MRA333 | MRA333B | MRA163 | MRA163B | MRA363 | MRA363B |
| I _{FSM} (Amps) | 3000 | 3000 | 2000 | 2000 | 6000 | 6000 | 5000 | 5000 |
| I _O Free Convection (Amps) | 75 | 75 | 75 | 75 | 125 | 125 | 150 | 150 |
| T _A @ Rated I _O (1500 FLM or Free Convection (°C) | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 |
| T _J (Max) (°C) | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 |

Fast Recovery Rectifiers









... available for designs requiring a power rectifier having maximum switching times ranging from 200 ns to 750 ns. These devices are offered in current ranges of 1.0 to 50 amperes and in voltages to 600 volts. Higher voltages are available upon request, but a necessary trade-off against switching speeds results. Reverse polarity (anode to case) obtained by adding an "R" suffix.

| I _O , AVERAGE RECTIFIED FORWARD CURRENT (Amperes) | | | | | | | | | | | | | |
|---|--|--|--|--|--|--|--|--|--|--|--|--|--|
| Case < | | | | | | | | | | | | | |

*Must be derated for reverse power dissipation. See Data Sheet.
 Package Size: 0.120" Max Diameter by 0.260" Max Length.

Hot Carrier Rectifiers

... Schottky barrier devices, ideal for use in low voltage, high frequency power supplies and as free-wheeling diodes. These units feature very low forward voltages and switching times estimated at less than 10 ns. They are offered in current ranges of 0.5 to 5.0 amperes and in voltages to 30. Reverse polarity (anode to case) is not available.

| I _O , AVERAGE RECTIFIED FORWARD CURRENT (Amperes) | | | | | | | | | | | | |
|--|---|---|---|---|---|--------|---|--------|---|--------|---|-----------|
| V _{RRM} (Volts) | 0.5 | | 1.0 | | 3.0 | | 3.0 | | 5.0 | | 15 | |
| | 51-02 Glass | 59-04 Plastic | 267 Plastic | 60 Metal | 245 (DO-4) Metal | | 25 | | 40 | | 40 | |
| |  |  |  |  |  | |  | |  | |  | |
| 20 | M8R020 | 1N5817 | 1N5820 | M8R320M | 1N5823 | 1N5826 | M8R1520 | 1N5829 | M8R2520 | 1N5832 | M8R4020 | M8R4020PF |
| 30 | M8R030 | 1N5818 | 1N5821 | M8R330M | 1N5824 | 1N5827 | M8R12530 | 1N5830 | M8R2530 | 1N5833 | M8R4030 | M8R4030PF |
| I _{FSM} (Amps) | 5.0 | 100 | | 500 | 500 | 500 | 500 | 800 | 800 | 800 | 800 | 800 |
| *T _C @Rated I _O (°C) | | | | | | 85 | 80 | 85 | 80 | 75 | 70 | 50 |
| T _A = 75°C PC Board Mount | 125 | | | | | | | | | | | |
| *T _L @(Rated I _O) (°C) | | 90 | 95 | 90 | 80 | | | | | | | |
| T _J (Max) (°C) | | 125 | 125 | 125 | 125 | 125 | 125 | 125 | 125 | 125 | 125 | 125 |
| *Max V _F @ I _{FM} = I _O | 0.50 | 0.55 | 0.50 | 45 @ 5 A | 0.37 | 0.47 | 0.55 | 0.46 | 0.55 | 0.55 | 0.63 | 0.63 |

* Values are for the 30 Volt units. The lower voltage parts provide lower limits.

‡ Must be derated for reverse power dissipation. See Data Sheet.

High Voltage Diodes and Stacks

... low-current, high-voltage diodes and stacks in current ranges of 250 mA to 1.0 ampere and in voltages from 1000 to 5000 volts.

| 250 mA High Voltage Diodes | |
|-------------------------------------|----------------|
| Case | 169-02 Plastic |
| V_{RRM} (Volts) | |
| 1000 | MR250-1 |
| 2000 | MR250-2 |
| 3000 | MR250-3 |
| 4000 | MR250-4 |
| 5000 | MR250-5 |
| I_{FSM} (Amps) | 15 |
| T_A @ Rated I_D ($^{\circ}C$) | 75 |
| T_J (Max) ($^{\circ}C$) | 150 |

| 1.0 Ampere Television Dampener Diode | |
|---|---------------|
| Case | 59-04 Plastic |
| V_{RRM} (Volts) | |
| 1000 | MR1-1000 |
| 1200 | MR1-1200 |
| 1400 | MR1-1400 |
| 1600 | MR1-1600 |
| I_{FSM} (Amps) | 30 |
| T_A @ Rated I_D ($^{\circ}C$) | 75* |
| T_J (Max) ($^{\circ}C$) | 175 |
| t_{rr} (μs) | 25 |
| *Must be derated for reverse power dissipation. See Data Sheet. | |

| Low Voltage Rectifiers | |
|--|---------|
| ... for low voltage applications to suppress reverse power transients. | |
| Avalanche Rectifiers | |
| Case | 269-03 |
| V_{RRM} (Volts) | |
| 23 | MR2525 |
| 25 | MR2525R |
| BV (Volts) | 24-32 |
| I_{FSM} (Amps) | 600 |
| T_C @ Rated I_D ($^{\circ}C$) | 150 |
| T_J (Max) ($^{\circ}C$) | 175 |

| Solid-State Mercury Vapor Tube Replacements | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--|-----------|--|--------|--|--|-----|-----|-----|---|--------|--------|---|-------|-------|---|-------|-------|---|-------|-------|---|-----------|--|---|-----------|--|---|-------|-------|---|-------|-------|---|-----------|--|---|-------|-------|
| Case 286-03 | | <table><tr><th colspan="3">INCHES</th></tr><tr><th>DIM</th><th>MIN</th><th>MAX</th></tr><tr><td>A</td><td>10.505</td><td>10.625</td></tr><tr><td>B</td><td>2.185</td><td>2.225</td></tr><tr><td>C</td><td>1.405</td><td>1.470</td></tr><tr><td>D</td><td>0.490</td><td>0.510</td></tr><tr><td>E</td><td colspan="2">0.750 BSC</td></tr><tr><td>F</td><td colspan="2">0.744 BSC</td></tr><tr><td>G</td><td>0.559</td><td>0.569</td></tr><tr><td>J</td><td>0.658</td><td>0.698</td></tr><tr><td>K</td><td colspan="2">0.562 BSC</td></tr><tr><td>L</td><td>2.480</td><td>2.520</td></tr></table> | INCHES | | | DIM | MIN | MAX | A | 10.505 | 10.625 | B | 2.185 | 2.225 | C | 1.405 | 1.470 | D | 0.490 | 0.510 | E | 0.750 BSC | | F | 0.744 BSC | | G | 0.559 | 0.569 | J | 0.658 | 0.698 | K | 0.562 BSC | | L | 2.480 | 2.520 |
| | | | INCHES | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| DIM | MIN | MAX | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| A | 10.505 | 10.625 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | 2.185 | 2.225 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | 1.405 | 1.470 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | 0.490 | 0.510 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | 0.750 BSC | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F | 0.744 BSC | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| G | 0.559 | 0.569 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| J | 0.658 | 0.698 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| K | 0.562 BSC | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| L | 2.480 | 2.520 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| V_{RRM} (Volts) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 30,000 | MDA6693 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| I_O (Amps) | 5.0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| I_{FSM} (Amps) | 400 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| T_A @ Rated I_D ($^{\circ}C$) | 75 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| T_J (Max) ($^{\circ}C$) | 175 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| v_F @ $I_F = 20$ A (Volts) IPulse Width 10 ms, ≤ 1% Duty Cycle) | 38 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MDA872A, MDA575A, Mercury Vapor Tube Replacements Available. Consult Factory. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |



THYRISTERS

and TRIGGERS

**SILICON CONTROLLED RECTIFIERS (SCRs) AND
TRIACs**
(0.8 to 80 Amperes; 15 to 800 Volts)

Motorola's extensive line of thyristors consists of two generic component categories — SCRs and Triacs. Within each of these categories are two basic packaging divisions, plastic and metal — plastic for lowest cost and metal hermetically sealed packages for applications requiring highest reliability. Combined, these divisions include a large number of individual devices covering a forward-current range from 0.8 to 80 Amperes and a blocking voltage range from 15 to 800 Volts.

But the availability of devices for a wide range of current and voltage requirements doesn't begin to tell the whole story. For within the large selection of different series numbers are device families with characteristics designed for specifically designated applications. Here are some examples of preferred device families for the more high-volume applications, and for special unique purposes.

TABLE OF CONTENTS

| | Page |
|---|-------|
| THYRISTOR DEVICES | |
| SCRs in Plastic Packages (0.8 — 16 Amp) | 4-98 |
| Triacs in Plastic Packages (0.45 — 12 Amp) | 4-99 |
| SCRs in Metal Packages (1.6 — 35 Amp) | 4-100 |
| Triacs in Metal Packages (15 — 40 Amp) | 4-101 |
| Pulse Modulators in Metal Packages (80 Amp) | 4-103 |
| TRIGGER DEVICES | |
| Unijunction Transistors | 4-104 |
| Programmable Unijunction Transistors | 4-105 |
| Diac (3-Layer Diodes) | 4-105 |
| Silicon Bidirectional Switch | 4-105 |
| 4-Layer Diodes | 4-105 |
| Silicon Unidirectional Switch | 4-105 |

The following index reflects the devices characterized in this section. To locate the exact page number, see Catalog Index(Page 7-1).

INDEX






| | | | |
|----------|------------|------------|----------|
| 1N5159 | 2N2577 | 2N5081 | 2N6169 |
| 1N5160 | 2N2578 | 2N5082 | 2N6170 |
| 1N5758,A | 2N2579 | 2N5083 | 2N6171 |
| 1N5759,A | 2N2646 | 2N5084 | 2N6172 |
| 1N5760,A | 2N2647 | 2N5164 | 2N6173 |
| 1N5761,A | 2N2687 | 2N5165 | 2N6174 |
| 1N5762,A | 2N2688 | 2N5166 | 2N6236 |
| 1N5779 | 2N2689 | 2N5167 | 2N6237 |
| 1N5780 | 2N2690 | 2N5168 | 2N6238 |
| 1N5781 | 2N3870 | 2N5169 | 2N6239 |
| 1N5782 | 2N3871 | 2N5170 | 2N6240 |
| 1N5783 | 2N3872 | 2N5171 | 2N6241 |
| 1N5784 | 2N3873 | 2N5431,JAN | 2N6342,A |
| 1N5785 | 2N3896 | 2N5441 | 2N6343,A |
| 1N5786 | 2N3897 | 2N5442 | 2N6344,A |
| 1N5787 | 2N3898 | 2N5443 | 2N6345,A |
| 1N5788 | 2N3899 | 2N5444 | 2N6346,A |
| 1N5789 | 2N3980 | 2N5445 | 2N6347,A |
| 1N5790 | 2N4167 | 2N5446 | 2N6348,A |
| 1N5791 | 2N4168 | 2N5567 | 2N6349,A |
| 1N5792 | 2N4169 | 2N5568 | 2N6394 |
| 1N5793 | 2N4170 | 2N5569 | 2N6395 |
| 2N681 | 2N4171 | 2N5570 | 2N6396 |
| 2N682 | 2N4172 | 2N5571 | 2N6397 |
| 2N683 | 2N4173 | 2N5572 | 2N6398 |
| 2N684 | 2N4174 | 2N5573 | 2N6399 |
| 2N685 | 2N4183 | 2N5574 | 2N6400 |
| 2N686 | 2N4184 | 2N6027 | 2N6401 |
| 2N687 | 2N4185 | 2N6028 | 2N6402 |
| 2N688 | 2N4186 | 2N6068,A,B | 2N6403 |
| 2N689 | 2N4187 | 2N6069,A,B | 2N6404 |
| 2N690 | 2N4188 | 2N6070,A,B | 2N6405 |
| 2N691 | 2N4189 | 2N6071,A,B | MAC10-1 |
| 2N692 | 2N4190 | 2N6072,A,B | MAC10-2 |
| 2N1595 | 2N4199,JAN | 2N6073,A,B | MAC10-3 |
| 2N1596 | 2N4200,JAN | 2N6074,A,B | MAC10-4 |
| 2N1597 | 2N4201,JAN | 2N6075,A,B | MAC10-5 |
| 2N1598 | 2N4202,JAN | 2N6116 | MAC10-6 |
| 2N1599 | 2N4203,JAN | 2N6117 | MAC10-7 |
| 2N1842,A | 2N4204,JAN | 2N6118 | MAC10-8 |
| 2N1843,A | 2N4212 | 2N6145 | MAC11-1 |
| 2N1844,A | 2N4213 | 2N6146 | MAC11-2 |
| 2N1845,A | 2N4214 | 2N6147 | MAC11-3 |
| 2N1846,A | 2N4215 | 2N6151 | MAC11-4 |
| 2N1847,A | 2N4216 | 2N8152 | MAC11-5 |
| 2N1848,A | 2N4217 | 2N8153 | MAC11-6 |
| 2N1849,A | 2N4218 | 2N8154 | MAC11-7 |
| 2N1850,A | 2N4219 | 2N8155 | MAC11-8 |
| 2N2322 | 2N4441 | 2N8156 | MAC35-1 |
| 2N2323 | 2N4442 | 2N6157 | MAC35-2 |
| 2N2324 | 2N4443 | 2N6158 | MAC35-3 |
| 2N2325 | 2N4444 | 2N6159 | MAC35-4 |
| 2N2326 | 2N4851 | 2N6160 | MAC35-5 |
| 2N2327 | 2N4852 | 2N6161 | MAC35-6 |
| 2N2328 | 2N4853 | 2N6162 | MAC35-7 |
| 2N2329 | 2N4870 | 2N6163 | MAC35-8 |
| 2N2573 | 2N4871 | 2N8164 | MAC35 10 |
| 2N2574 | 2N4948 | 2N6165 | MAC35-1 |
| 2N2575 | 2N4949 | 2N6167 | MAC36-2 |
| 2N2576 | 2N5060 | 2N6168 | MAC36-3 |

| | | | |
|----------|------------|-------------|-------------|
| MAC36-4 | MAC5442 | MCR107-2 | MCR2305-8 |
| MAC36-5 | MAC5443 | MCR107-3 | MCR2305-10 |
| MAC36-6 | MAC5444 | MCR107-4 | MCR2604L-1 |
| MAC36-7 | MAC5445 | MCR107-5 | MCR2604L-2 |
| MAC36-8 | MAC5446 | MCR107-6 | MCR2604L-3 |
| MAC36-10 | MAC6400-80 | MCR107-7 | MCR2604L-4 |
| MAC37-1 | MAC6410-80 | MCR107-8 | MCR2604L-5 |
| MAC37-2 | MAC6420-80 | MCR115 | MCR2604L-6 |
| MAC37-3 | M854991 | MCR120 | MCR2604L-8 |
| MAC37-4 | M854992 | MCR201 | MCR2604L-10 |
| MAC37-5 | MCR80-5 | MCR220-5 | MCR3000-1 |
| MAC37-6 | MCR80-10 | MCR220-7 | MCR3000-2 |
| MAC37-7 | MCR80-20 | MCR220-9 | MCR3000-3 |
| MAC37-8 | MCR80-30 | MCR221-5 | MCR3000-4 |
| MAC37-10 | MCR80-40 | MCR221-7 | MCR3000-5 |
| MAC38-1 | MCR80-50 | MCR221-9 | MCR3000-6 |
| MAC38-2 | MCR80-60 | MCR406-1 | MCR3000-7 |
| MAC38-3 | MCR80-70 | MCR406-2 | MCR3000-8 |
| MAC38-4 | MCR80-80 | MCR406-3 | MCR3000-9 |
| MAC38-5 | MCR81-5 | MCR406-4 | MCR3000-10 |
| MAC38-6 | MCR81-10 | MCR407-1 | MCR3818-1 |
| MAC38-7 | MCR81-20 | MCR407-2 | MCR3818-3 |
| MAC38-8 | MCR81-30 | MCR407-3 | MCR3818-5 |
| MAC38-10 | MCR81-40 | MCR407-4 | MCR3818-7 |
| MAC92-1 | MCR81-50 | MCR649AP-1 | MCR3818-10 |
| MAC92-2 | MCR81-60 | MCR649AP-2 | MCR3918-1 |
| MAC92-3 | MCR81-70 | MCR649AP-3 | MCR3918-3 |
| MAC92-4 | MCR81-80 | MCR649AP-4 | MCR3918-6 |
| MAC92-5 | MCR82-5 | MCR649AP-5 | MCR3918-7 |
| MAC92-6 | MCR82-10 | MCR649AP-6 | MCR3918-10 |
| MAC92A-1 | MCR82-20 | MCR649AP-7 | MCR3835-1 |
| MAC92A-2 | MCR82-30 | MCR649-8 | MCR3835-2 |
| MAC92A-3 | MCR82-40 | MCR649AP-8 | MCR3835-5 |
| MAC92A-4 | MCR82-50 | MCR649-9 | MCR3835-7 |
| MAC92A-5 | MCR82-60 | MCR649AP-9 | MCR3835-8 |
| MAC92A-6 | MCR82-70 | MCR649-10 | MCR3835-9 |
| MAC220-2 | MCR82-80 | MCR649AP-10 | MCR3835-10 |
| MAC220-3 | MCR83-5 | MCR729-5 | MCR3935-1 |
| MAC220-5 | MCR83-10 | MCR729-6 | MCR3935-2 |
| MAC220-7 | MCR83-20 | MCR729-7 | MCR3935-5 |
| MAC220-9 | MCR83-30 | MCR729-8 | MCR3935-7 |
| MAC221-2 | MCR83-40 | MCR729-9 | MCR3935-8 |
| MAC221-3 | MCR83-50 | MCR729-10 | MCR3935-9 |
| MAC221-5 | MCR83-60 | MCR846-1 | MCR3935-10 |
| MAC221-7 | MCR83-70 | MCR846-2 | MPT20 |
| MAC221-9 | MCR83-80 | MCR846-3 | MPT28 |
| MAC40688 | MCR101 | MCR846-4 | MPT32 |
| MAC40689 | MCR102 | MCR1718-5 | MPU131 |
| MAC40690 | MCR103 | MCR1718-6 | MPU132 |
| MAC40795 | MCR104 | MCR1718-7 | MPU133 |
| MAC40796 | MCR106-1 | MCR1718-8 | MPU6027 |
| MAC40797 | MCR106-2 | MCR1906-1 | MPU6028 |
| MAC40798 | MCR106-3 | MCR1906-2 | MU10 |
| MAC40799 | MCR106-4 | MCR1906-3 | MU20 |
| MAC40800 | MCR106-5 | MCR1906-4 | MU2646 |
| MAC40801 | MCR106-6 | MCR2305-1 | MU4891 |
| MAC4688 | MCR106-7 | MCR2305-2 | MU4892 |
| MAC4689 | MCR106-8 | MCR2305-3 | MU4893 |
| MAC4690 | MCR106-9 | MCR2305-4 | MU4894 |
| MAC5441 | MCR106-10 | MCR2305-5 | MU54987 |
| | MCR107-1 | MCR2305-6 | MU54988 |






THYRISTORS in PLASTIC PACKAGES

Excellent reliability and low cost make Motorola plastic-packaged thyristors the preferred devices for high-volume, low and medium current applications. Batch-processed, high-impact plastic provides outstanding mechanical ruggedness while oxide or glass surface passivation protects each die against impurity contamination and moisture penetration for long-term electrical stability.

SCRs

| ON-STATE (RMS) CURRENT | | | | | | | | | | |
|--|------------------------------------|---|--------|---|----------|---|----------|---|----------|---|
| | | 0.8 AMP | | 4.0 AMP | | 8.0 AMP | | 12 AMP | | 16 AMP |
| | |  | |  | |  | |  | |  |
| | | Case 29-02 TO-92 Style 10 | | Case 77-03 Style 2 | | Case 90-05 Style 1 | | Case 90-05 Style 1 | | Case 221-02 TO-220 AB Style 1 |
| V _{DRM} V _{RRM} Blocking Voltage (DC or peak) Volts | 15 V | MCR101 | — | — | — | — | — | — | — | — |
| | 25 V | — | — | — | — | — | — | MCR3000-1 | — | — |
| | 30 V | MCR102 2N5060 | 2N6236 | MCR106-1 | MCR107-1 | MCR406-1 | MCR407-1 | — | — | — |
| | 50 V | — | 2N6237 | — | — | — | — | 2N4441 MCR3000-2 | 2N6394 | 2N6400 |
| | 60 V | MCR103 2N5061 | — | MCR106-2 | MCR107-2 | MCR406-2 | MCR407-2 | — | — | — |
| | 100 V | MCR104 2N5062 | 2N6238 | MCR106-3 | MCR107-3 | MCR406-3 | MCR407-3 | MCR3000-3 | 2N6395 | 2N6401 |
| | 150 V | MCR115 2N5063 | — | — | — | — | — | — | — | — |
| | 200 V | MCR120 2N5064 | 2N6239 | MCR106-4 | MCR107-4 | MCR406-4 | MCR407-4 | 2N4442 MCR3000-4 | 2N6396 | 2N6402 |
| | 300 V | — | — | MCR106-5 | MCR107-5 | — | — | MCR3000-5 | MCR220-5 | MCR221-5 |
| | 400 V | — | 2N6240 | MCR106-6 | MCR107-6 | — | — | 2N4443 MCR3000-6 | 2N6397 | 2N6403 |
| | 500 V | — | — | MCR106-7 | MCR107-7 | — | — | MCR3000-7 | MCR220-7 | MCR221-7 |
| ELECTRICAL CHARACTERISTICS | 600 V | — | 2N6241 | MCR106-8 | MCR107-8 | — | — | 2N4444 MCR3000-8 | 2N6398 | 2N6404 |
| | 700 V | — | — | MCR106-9 | — | — | — | MCR3000-9 | MCR220-9 | MCR221-9 |
| | 800 V | — | — | MCR106-10 | — | — | — | MCR3000-10 | 2N6399 | 2N6405 |
| | I _{TSM} (Amp) | 6.0 | 25 | 25 | 25 | 30 | 20 | 80 | 100 | 160 |
| | I _{GT} @ 25°C (mA) Max | 0.2 | 0.2 | 0.2 | 20 | 0.2 | 0.6 | 30 | 30 | 30 |
| V _{GT} @ 25°C (V) Max | | 0.8 | 0.8 | 1.0 | 1.5 | 0.8 | 1.0 | 1.5 | 1.5 | 1.5 |
| I _H @ 25°C (mA) Max | | 5.0 | 3.0 | 5.0 | 20 | 3.0 | 5.0 | 40 | 40 | 40 |

Triacs








| ON-STATE (RMS) CURRENT | | | | | | | | | |
|---|-----------------------------|---|---------|---|---------|---|-------------------|---|---------|
| 0.45 AMP | | 4.0 AMP | | 8.0 AMP | | 10 AMP | | 12 AMP | |
|  | |  | |  | |  | |  | |
| Case 29-02 TO-92 Style 12 | | Case 77-03 Style 5 | | Case 221-02 TO-220 AB Style 2 | | Case 90-05 Style 4 | | Case 221-02 TO-220 AB Style 2 | |
| V _{DRM} Blocking Voltage (DC or Peak) Volts | 25 V | — | 2N6068 | 2N6068A | 2N6068B | — | MAC11-1 | MAC10-1 | — |
| | 30 V | MAC92-1 MAC92A-1* | — | — | — | — | — | — | — |
| | 50 V | — | 2N6069 | 2N6069A | 2N6069B | MAC220-2 MAC221-2 | MAC11-2 | MAC10-2 | — |
| | 60 V | MAC92-2 MAC92A-2* | — | — | — | — | — | — | — |
| | 100 V | MAC92-3 MAC92A-3* | 2N6070 | 2N6070A | 2N6070B | MAC220-3 MAC221-3 | MAC11-3 | MAC10-3 | — |
| | 200 V | MAC92-4 MAC92A-4* | 2N6071 | 2N6071A | 2N6071B | 2N6342 2N6346 | 2N6154 MAC11-4 | 2N6151 MAC10-4 | 2N6342A |
| | 300 V | MAC92-5 MAC92A-5* | 2N6072 | 2N6072A | 2N6072B | MAC220-5 MAC221-5 | MAC11-5 | MAC10-5 | — |
| | 400 V | MAC92-6 MAC92A-6* | 2N6073 | 2N6073A | 2N6073B | 2N6343 2N6347 | 2N6155 MAC11-6 | 2N6152 MAC10-6 | 2N6343A |
| | 500 V | — | 2N6074 | 2N6074A | 2N6074B | MAC220-7 MAC221-7 | MAC11-7 | MAC10-7 | — |
| | 600 V | — | 2N6075 | 2N6075A | 2N6075B | 2N6344 2N6348 | 2N6156 MAC11-8 | 2N6153 MAC10-8 | 2N6344A |
| | 700 V | — | — | — | — | MAC220-9 MAC221-9 | — | — | — |
| | 800 V | — | — | — | — | 2N6345 2N6349 | — | — | 2N6345A |
| ELECTRICAL CHARACTERISTICS | I _{GT} @ 25°C (mA) | | | | | | | | |
| | MT2(+), G(+) | 5.0 | 30 | 50 | 30 | 60 | 50 | 50 | 50 |
| | MT2(+), G(-) | 15* | — | 50 | 30 | 75# | — | 75 | 75 |
| | MT2(-), G(-) | 5.0 | 30 | 50 | 30 | 50 | 50 | 50 | 50 |
| | MT2(-), G(+) | 15* | — | 10 | 50 | 75# | — | 75 | 75 |
| | V _{GT} @ 25°C (V) | | @ -40°C | @ -40°C | @ -40°C | | | | |
| | MT2(+), G(+) | 2.0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.0 | 2.0 | 2.0 |
| | MT2(+), G(-) | 2.0* | — | 2.5 | 2.5 | 2.5# | — | 2.5 | 2.5 |
| | MT2(-), G(-) | 2.0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.0 | 2.0 | 2.0 |
| | MT2(-), G(+) | 2.0* | — | 2.5 | 2.5 | 2.5# | — | 2.5 | 2.5 |
| | I _{TSM} (Amp) | 5.0 | 30 | 30 | 30 | 100 | 100 | 100 | 120 |

* Denotes A Version

Denotes 2N6346 thru 2N6349 and MAC221 Series only.







SCRs in METAL PACKAGES





For current handling requirements up to 80 Amperes, with up to 800-Volt blocking potential, Motorola metal packaged SCRs combine highest reliability with the design flexibility offered by a wide variety of package options. Pulse modulator SCRs provide pulse current capacity to 1000 Amperes for radar and similar applications.

| ON STATE (RMS) CURRENT | | | | | | | | | | | | |
|---|------------------------------------|---|---------|--------|--------|---|---------------------|---|---|--|---|---|
| 0.5 AMP | | 1.5 AMP | | | | 3.0 AMP | | 16 AMP | 20 AMP | | | |
|  | |  | | | |  | |  |  |  |  |  |
| Case 22-03 TO-18 Style 6 | | Case 79-02 TO-39 Style 3 | | | | Case 86 Style 1 | | Case 87L Style 1 | Case 263-03 Style 1 | Case 310-01 Style 1 | Case 263-03 Style 1 | Case 311-01 Style 1 |
| V _{DRM} V _{RRM} Blocking Voltage (OC or Peak) Volts | 15 V | MCR201 | — | — | — | — | — | — | — | — | — | — |
| | 25 V | — | — | 2N2222 | 2N4212 | MCR1006-1 | 2N4167 MCR2305-1 | 2N4183 MCR2504L-1 | 2N1842 2N1842A | MCR3818-1 | MCR3918-1 | — |
| | 30 V | 2N2687 | — | — | — | — | — | — | — | — | — | — |
| | 50 V | — | 2N1595 | 2N2323 | 2N4212 | MCR1006-2 | 2N4168 MCR2305-2 | 2N4184 MCR2504L-2 | 2N1842 2N1842A | 2N5164 | 2N5168 | — |
| | 60 V | 2N2688 | — | — | — | — | — | — | — | — | — | — |
| | 100 V | 2N2689 | 2N1596 | 2N2324 | 2N4214 | MCR1006-3 | 2N4169 MCR2305-3 | 2N4185 MCR2504L-3 | 2N1844 2N1844A | MCR3818-3 | MCR3918-2 | 2N6167 |
| | 150 V | — | — | 2N2225 | 2N4215 | — | — | — | 2N1845 2N1845A | — | — | — |
| | 200 V | 2N2690 | 2N1697 | 2N2326 | 2N4218 | MCR1006-4 | 2N4170 MCR2305-4 | 2N4186 MCR2504L-4 | 2N1846 2N1846A | 2N5165 | 2N5169 | 2N6168 |
| | 250 V | — | — | 2N2227 | 2N4217 | — | — | — | 2N1847 2N1847A | — | — | — |
| | 300 V | — | 2N1608 | 2N2328 | 2N4218 | — | 2N4171 MCR2305-5 | 2N4187 MCR2504L-5 | 2N1848 2N1848A | MCR3818-5 | MCR3918-5 | — |
| | 400 V | — | 2N1599 | 2N2228 | 2N4219 | — | 2N4172 MCR2305-6 | 2N4188 MCR2504L-6 | 2N1849 2N1849A | 2N5166 | 2N5170 | 2N6169 |
| | 500 V | — | — | — | — | — | 2N4173 | 2N4189 | 2N1850 2N1850A | MCR3818-7 | MCR3918-7 | — |
| | 600 V | — | — | — | — | — | 2N4174 MCR2305-8 | 2N4190 MCR2504L-8 | — | 2N5167 | 2N5171 | 2N6170 |
| | 700 V | — | — | — | — | — | — | — | — | — | — | — |
| | 800 V | — | — | — | — | — | MCR2306-10 | MCR2504L-10 | — | MCR3818-10 | MCR2918-10 | — |
| ELECTRICAL CHARACTERISTICS | I _{TSM} (Amp) | 5.0 | 16 | 16 | 15 | 15 | 100 | 125 | 240 | 240 | 40 | 50 |
| | I _{GT} @ 25°C (mA) Max | 0.7 | 10 | 0.2 | 0.1 | 1.0 | 30 | 80 | 80 | 40 | 40 | 50 |
| | V _{GT} @ 25°C (V) Max | 1.0 | 2.0 | 0.8 | 0.8 | 1.0 | 1.5 | 2.0 | 1.5 | 1.5 | 1.5 | 1.5 |
| | I _H @ 25°C (mA) Max | 2.0 | 5.0 Typ | 2.0 | 2.0 | 5.0 | 20 | — | — | — | — | — |

HIGH CURRENT SCRs in METAL PACKAGES

SCRs in METAL PACKAGES (continued)

| ON-STATE (RMS) CURRENT | | | | | |
|---|---|---|---|---|---|
| 25 AMP | | | 35 AMP | | |
|  |  |  |  |  |  |
| Case 54 Style 2 | Case 61 TO-41 Style 1 | Case 263-03 Style 1 | Case 310-01 Style 1 | Case 263-03 Style 1 | Case 311-01 Style 1 |
| — | — | — | — | — | — |
| MCR649AP-1 | 7N7577 | 7N681 | MCR7875-1 | MCR7935-1 | — |
| — | — | — | — | — | — |
| MCR649AP-7 | 7N7574 | 7N687 | MCR3835-7 | MCR7975-7 | — |
| — | — | — | — | — | — |
| MCR649AP-3 | 7N7575 | 7N687 | 7N7870 | 7N3885 | 7N6171 |
| — | — | 7N654 | — | — | — |
| MCR649AP-4 | 7N7576 | 7N685 | 7N3871 | 7N7897 | 7N6177 |
| — | — | 7N855 | — | — | — |
| MCR649AP-5 | 7N2577 | 7N687 | MCR3875-5 | MCR7935-5 | — |
| MCR649AP-6 | 7N7678 | 7N688 | 7N3877 | 7N3898 | 7N6177 |
| MCR649AP-7 | 7N7575 | 7N689 | MCR3835-7 | MCR7975-7 | — |
| MCR649AP-8 | MCR649-8 | 7N689 | 7N7873 MCR7835-8 | 7N3898 MCR7975-8 | 7N6174 |
| MCR649AP-8 | MCR649-9 | 7N691 | MCR7835-9 | MCR7975-9 | — |
| MCR649AP-10 | MCR649-10 | 7N697 | MCR7875-10 | MCR7935-10 | — |
| 250 | 750 | 700 | 350 | 350 | — |
| 40 | 49 | 75 | 40 | 40 | — |
| 7.5 | 7.5 | 7.0 | 1.5 | 1.5 | — |
| 20 Typ | 70 Typ | 79 Typ | 50 | 50 | — |

| ON-STATE RMS CURRENT | | | | |
|---|---|--|---|----------|
| 80 AMP | | | | |
|  |  |  |  | |
| Case 287-01 Style 1 | Case 788-01 Style 1 | Case 291-01 Style 1 | Case 285-01 Style 1 | |
| 25 V | — | — | — | — |
| 50 V | MCR80-5 | MCR81-5 | MCR82-5 | MCR83-5 |
| 100 V | MCR80-10 | MCR81-10 | MCR82-10 | MCR83-10 |
| 200 V | MCR80-20 | MCR81-20 | MCR82-20 | MCR83-20 |
| 300 V | MCR80-30 | MCR81-30 | MCR82-30 | MCR83-30 |
| 400 V | MCR80-40 | MCR81-40 | MCR82-40 | MCR83-40 |
| 500 V | MCR80-50 | MCR81-50 | MCR82-50 | MCR83-50 |
| 600 V | MCR80-60 | MCR81-60 | MCR82-60 | MCR83-60 |
| 700 V | MCR80-70 | MCR81-70 | MCR82-70 | MCR83-70 |
| 800 V | MCR80-80 | MCR81-80 | MCR82-80 | MCR83-80 |
| ELECTRICAL CHARACTERISTICS | I_{TSM} (Amp) | 1000 | 1000 | 1000 |
| | $I_{GT} @ 25^{\circ}C$ (mA) Max | 70 | 70 | 70 |
| | $V_{GT} @ 25^{\circ}C$ (V) Max | 3.0 | 3.0 | 3.0 |
| | $I_H @ 25^{\circ}C$ (mA) Max | 70 | 70 | 70 |
| | t_{q1} (μs) Typ | 70 | 70 | 70 |
| | dv/dt (V/ μs) Typ | 100 | 100 | 100 |
| | | | | |

TRIACs in METAL PACKAGES





Hermetically sealed for highest reliability in control applications to 40 Amperes and voltage to 800 Volts. Wide variety of package options simplifies mechanical design.



| ON-STATE IRMS CURRENT | | | | | | | | | | | | | |
|--|----------------------------|------------------------|------------------------|------------------------------------|------------------------|------------------------|------------------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| | | 10 AMP | | | 15 AMP | | | 25 AMP | | | 30 AMP | | |
| | | | | | | | | | | | | | |
| | | Case 174-03 Style 3 | Case 135-02 Style 3 | Isolated Case 235-02 Style 2 | Case 174-03 Style 3 | Case 175-02 Style 3 | Isolated Case 235-03 Style 2 | Case 134-03 Style 3 | Case 135-02 Style 3 | Case 134-03 Style 3 | Case 175-03 Style 3 | Case 175-03 Style 3 | Case 175-03 Style 3 |
| V _{ORM} Blocking Voltage (DC or Peak) Volts | 25 V | | | | | | - | VAC35 1 | VAC33 1 | VAC38 1 | VAC38 1 | - | - |
| | 50 V | - | | - | | | | VAC35 7 | VAC33 3 | VAC38 3 | VAC38 3 | - | - |
| | 100 V | | | - | | - | | VAC35 3 | MAC31 3 | MAC36 3 | MAC38 3 | - | - |
| | 200 V | 3N5567 | 3N5569 | VAC40709 | 3N5571 | 3N5573 | 7N6145 | MAC35 4 | MAC31 4 | MAC36 4 | MAC38 4 | 3N6157 | 7N6150 |
| | 300 V | - | - | - | | - | - | MAC35 5 | MAC33 5 | MAC38 5 | MAC38 5 | - | - |
| | 400 V | 3N5568 | 3N5570 | VAC40800 | 3N5572 | 7N5574 | 2N6146 | MAC35 6 | MAC37 6 | MAC36 6 | MAC38 6 | 3N6158 | 3N6161 |
| | 500 V | | - | - | - | - | - | MAC35 7 | MAC37 7 | MAC38 7 | MAC38 7 | - | - |
| | 600 V | MAC40785 | MAC40788 | MAC40801 | MAC40787 | MAC40790 | 3N6147 | VAC35 8 | MAC37 8 | MAC36 8 | MAC38 8 | 3N6159 | 7N6163 |
| | 800 V | | | - | - | - | | MAC35 10 | MAC37 10 | MAC36 10 | MAC38 10 | - | - |
| ELECTRICAL CHARACTERISTICS | I _{GT} @25°C (mA) | | | | | | | | | | | | |
| | Maximum | | | | | | | | | | | | |
| | MT2(+),GI(-) | 35 | 75 | 35 | 50 | 50 | 50 | 75 | 75 | 75 | 35 | 60 | 80 |
| | MT2(+),GI(-) | 40 | 40 | 40 | 80 | 80 | 80 | 100 | | 100 | - | 70 | 70 |
| | MT2(-),GI(+) | 75 | 35 | 25 | 50 | 50 | 50 | 35 | 75 | 75 | 75 | 30 | 75 |
| | MT2(-),GI(+) | 40 | 40 | 40 | 80 | 80 | 80 | 100 | - | 100 | - | 100 | 100 |
| | V _{GT} @25°C (V) | | | | | | | | | | | | |
| | Maximum | | | | | | | | | | | | |
| | MT2(+),GI(-) | 2.5 | 3.5 | 2.5 | 3.5 | 2.5 | 3.5 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| | MT2(+),GI(-) | 3.0 | 2.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.0 | - | 3.0 | - | 3.1 | 3.1 |
| | MT2(-),GI(+) | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.8 | 3.0 | 3.0 | 3.0 | 3.0 | 3.1 | 3.1 |
| | MT2(-),GI(+) | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.0 | - | 3.0 | - | 3.5 | 3.8 |
| | I _{TSM} (Amp) | 100 | 100 | 100 | 100 | 100 | 100 | 335 | 338 | 325 | 335 | 280 | 280 |

PULSE MODULATOR SCRs

These devices are especially designed for pulse modulator applications in radar and similar equipment.

TRIACS IN METAL PACKAGES (continued)

| ON-STATE (RMS) CURRENT | | | |
|---|---|---|---|
| 30 AMP | | 50 AMP | |
|  |  |  |  |
| Isolated Case 311 01 Style 1 | Case 310 01 Style 1 | Case 263 03 Style 1 | Isolated Case 317 01 Style 1 |
| | | | |
| | | | |
| | | | |
| 2N5153 | 2N5441 MAC5441 | 2N5444 MAC5444 | MAC4068S MAC468S |
| | | | |
| 2N5154 | 2N5442 MAC5442 | 2N5445 MAC5445 | MAC4069S MAC469S |
| | | | |
| 2N5155 | 2N5443 MAC5443 | 2N5446 MAC5446 | MAC4069S MAC469S |
| | MAC5400 80 | MAC5410 80 | MAC5420 80 |
| | | | |
| 60 | 70 | 70 | 70 |
| 70 | 70 | 70 | 70 |
| 70 | 70 | 70 | 70 |
| 100 | 100 | 100 | 100 |
| | | | |
| 20 | 20 | 20 | 20 |
| 21 | 20 | 20 | 20 |
| 21 | 20 | 20 | 20 |
| 25 | 25 | 25 | 25 |
| | | | |
| 200 | 300 2N5441 S _W 200 MAC S _W | 300 2N5444 S 200 MAC S | 300-MAC4068 S _W 200 Rat |

| ON-STATE PULSE CURRENT | | | |
|--|---|---|-----------------------|
| | 100 AMP | 1000 AMP | |
| |  |  | |
| | Case 63-03 Style 1 TO-64 | Case 263-03 Style 1 | |
| V _{DRM} V _{RRM} Blocking Voltage (Volts) | 25 V | MCR846-1 | - |
| | 50 V | MCR846-2 | - |
| | 100 V | MCR846-3 | - |
| | 200 V | MCR846-4 | - |
| | 300 V | 2N4199 2N4199JAN | MCR729-5 MCR1718-5 |
| | 400 V | 2N4200 2N4200JAN | MCR729-6 MCR1718-6 |
| | 500 V | 2N4201 2N4201JAN | MCR729-7 MCR1718-7 |
| | 600 V | 2N4202 2N4202JAN | MCR729-8 MCR1718-8 |
| | 700 V | 2N4203 2N4203JAN | MCR729-9 |
| | 800 V | 2N4204 2N4204JAN | MCR729-10 |
| ELECTRICAL CHARACTERISTICS | I _{GT} @ 25°C (mA) Max | 50 | 50 |
| | V _{GT} @ 25°C (V) Max | 1.5 | 1.5 |
| | I _H @ 25°C (mA) Min Typ* | 3.0 | 25* |
| | t _{gt} (μs) Max Typ* | 0.4* | 0.5* 0.4* |
| | t _{off} (μs) Max Typ* | 20 | 5* 15*1 |
| | dv/dt (V/μs) Max Typ* | 250 | 50 |

* Applies to MCR729 Series only.

TRIGGER DEVICES



UJT



PUT



SBS



SUS



DIAC



4-LAYER

Trigger devices come under a variety of different classifications, with somewhat differing characteristics —

- Unijunction Transistors
- Unidirectional Switches
- Bidirectional Switches
- Bilateral Triggers
- 4-Layer Diodes



the principal function of all of these is to act as trigger devices for SCR and Triac circuits. Motorola makes them all, and with sufficient breadth of specifications to meet any circuit requirement.

The variety of different trigger devices available complicates device selection. No specific type of trigger has a clear-cut advantage over all others. Hence, trigger selection is often very subjective, based on the designer's experience and familiarity. Nevertheless, some basic comparisons can be drawn that might simplify the job of trigger selection for designers who have not already formed specific preferences.

UNIUNCTION TRANSISTORS — UJT

Highly stable devices for general-purpose trigger applications and as pulse generators (oscillators) and timing circuits. Useful at frequencies ranging (generally) from 1 Hz to 1 MHz. Available in low-cost plastic package (TO-92) and in hermetically sealed metal package (Case 22A).

UNIUNCTION TRANSISTORS — (UJT)



| Package | Device Type | η | | I_p μA Max | I_{EB20} μA Max | I_V mA Min |
|---|-------------|--------|------|----------------------|---------------------------|-----------------|
| | | Min | Max | | | |
| Plastic Case 29-02 (TO-92)  | MU10 | 0.60 | 0.85 | 5.0 | 1.0 | 1.0 |
| | 2N4870 | 0.56 | 0.75 | 5.0 | 1.0 | 2.0 |
| | 2N4871 | 0.70 | 0.85 | 5.0 | 1.0 | 4.0 |
| | MU2646 | 0.56 | 0.75 | 5.0 | 12 | 4.0 |
| | MU4891 | 0.56 | 0.82 | 5.0 | 0.01 | 2.0 |
| | MU4892 | 0.51 | 0.69 | 2.0 | | |
| | MU4893 | 0.55 | 0.82 | 2.0 | | |
| | MU4894 | 0.74 | 0.86 | 1.0 | | |
| Metal Case 22A-01  | MU20 | 0.56 | 0.85 | 2.0 | 0.2 | 1.0 |
| | 2N2646 | 0.56 | 0.75 | 5.0 | 12 | 4.0 |
| | 2N2647 | 0.68 | 0.82 | 2.0 | 0.2 | 8.0 |
| | 2N3980 | 0.68 | 0.82 | 2.0 | 0.01 | 1.0 |
| | 2N4851 | 0.56 | 0.75 | 2.0 | 0.1 | 2.0 |
| | 2N4852 | 0.70 | 0.85 | 2.0 | 0.1 | 4.0 |
| | 2N4853 | 0.70 | 0.85 | 0.4 | 0.05 | 6.0 |
| | 2N4948* | 0.55 | 0.82 | 2.0 | 0.01 | 2.0 |
| | 2N4949* | 0.74 | 0.86 | 1.0 | 0.01 | 2.0 |
| | 2N5431* | 0.72 | 0.80 | 0.4 | 0.01 | 2.0 |

* Also available as JAN and JANTX devices

THYRISTOR DEVICES (continued)

TRIGGER DEVICES (Continued)

PROGRAMMABLE UNIUNCTION TRANSISTORS – (PUT)

| Package | Device Type | I _p | | I _{GAO} @40 V | I _v | |
|---|-------------|---------------------------|----------------------------|---------------------------|---------------------------|----------------------------|
| | | R _G = 10 kΩ | R _G = 1.0 MΩ | | R _G = 10 kΩ | R _G = 1.0 MΩ |
| | | μA Max | μA Max | | μA Min | μA Max |
| Plastic Case 29-02 TO-92  | 2N6027 | 5.0 | 2.0 | 10 | 70 | 50 |
| | 2N6028 | 1.0 | 0.15 | 25 | 25 | 25 |
| | MPU6027 | 5.0 | 2.0 | ↓ | 70 | 50 |
| | MPU6028 | 1.0 | 0.15 | ↓ | 25 | 25 |
| | MPU131 | 5.0 | 2.0 | 5.0 | 70 | 50 |
| | MPU132 | 2.0 | 0.3 | 5.0 | 50 | 50 |
| Metal Case 22-03 TO-18  | 2N6116* | 5.0 | 2.0 | 5.0 | 70 | 50 |
| | 2N6117* | 2.0 | 0.3 | 5.0 | 50 | 50 |
| | 2N6118* | 1.0 | 0.15 | 5.0 | 50 | 25 |


*Also available as JAN and JANTX devices

PROGRAMMABLE UNIUNCTION TRANSISTORS – PUT

Similar to UJT's, except that I_v, I_p and intrinsic standoff voltage are programmable (adjustable) by means of external voltage divider. This stabilizes circuit performance for variations in device parameters. General operating frequency range is from 0.01 Hz to 10 kHz, making them suitable for long-duration timer circuits. Two-package availability provides cost option.

| Package | Device Type | V _S Volts Norm* | | I _S μA Max | I _H mA Max |
|---------|-------------|----------------------------------|-----|--------------------------|--------------------------|
| | | Min | Max | | |


BILATERAL TRIGGERS – (DIACs)

| | | | | |
|---|--------------|-----------|-----|--|
| Plastic Case 182-02 TO-92  | 1N5758/MPT20 | 20 ± 4.0* | 100 | |
| | 1N5759 | 24 ± 4.0* | 100 | |
| | 1N5760/MPT28 | 28 ± 4.0* | 100 | |
| | 1N5761/MPT32 | 32 ± 4.0* | 100 | |
| | 1N5762 | 36 ± 4.0* | 100 | |
| | 1N5758A | 20 ± 2.0* | 25 | |
| | 1N5759A | 24 ± 2.0* | 25 | |
| | 1N5760A | 28 ± 2.0* | 25 | |
| | 1N5761A | 32 ± 2.0* | 25 | |
| | 1N5762A | 36 ± 2.0* | 25 | |


SILICON BIDIRECTIONAL SWITCH – (SBS)

| | | | | | | |
|---|--------------------------------|--------------------|------------|-----------|------------|------------|
|  | Plastic Case 29-02 TO-92 | MBS4991 MBS4992 | 6.0 7.5 | 10 9.0 | 500 120 | 1.5 0.5 |
| | | | | | | |

4-LAYER DIODES (I_F = 150 mAdc Max)

| | | | | | |
|---|--------|-----|----|-----|-----|
| Glass Case 51 DO-7 Glass  | 1N5159 | 9.0 | 11 | 50 | 20 |
| | 1N5160 | 10 | 12 | ↓ | ↓ |
| | 1N5779 | 11 | 13 | ↓ | ↓ |
| | 1N5780 | 12 | 14 | ↓ | ↓ |
| | 1N5781 | 13 | 15 | 100 | 50 |
| | 1N5782 | 8.0 | 10 | ↓ | ↓ |
| | 1N5783 | 9.0 | 11 | ↓ | ↓ |
| | 1N5784 | 10 | 12 | ↓ | ↓ |
| | 1N5785 | 11 | 13 | ↓ | ↓ |
| | 1N5786 | 12 | 14 | ↓ | ↓ |
| | 1N5787 | 13 | 15 | ↓ | ↓ |
| | 1N5788 | 8.0 | 10 | ↓ | 2.0 |
| | 1N5789 | 9.0 | 11 | ↓ | ↓ |
| | 1N5790 | 10 | 12 | ↓ | ↓ |
| | 1N5791 | 11 | 13 | ↓ | ↓ |
| | 1N5792 | 12 | 14 | ↓ | ↓ |
| | 1N5793 | 13 | 15 | ↓ | ↓ |

SILICON UNIDIRECTIONAL SWITCH – (SUS)

| | | | | | | |
|---|--------------------------------|--------------------|------------|-----------|------------|------------|
|  | Plastic Case 29-02 TO-92 | MUS4987 MUS4988 | 6.0 7.5 | 10 9.0 | 600 150 | 1.5 0.5 |
| | | | | | | |

BILATERAL TRIGGERS – DIACs

Specifically designed as low-cost bidirectional triggers in line-operated Triac control circuits such as light dimmers, motor controls and temperature controls.

SILICON BIDIRECTIONAL SWITCH – SBS

Applications similar to Diac, but has gate electrode that permits synchronization.

4-LAYER DIODES

Small, axial-lead devices with stable, repeatable characteristics required for critical SCR trigger and pulse generator applications.

SILICON UNIDIRECTIONAL SWITCH – SUS

Similar to 4-Layer Diodes, but has gate electrode that permits synchronization.



OPTOELECTRONICS

Optoelectronic devices are designed for use in computer, industrial and consumer equipment. Motorola's standard line of optoelectronic products include optical couplers, light emitters and light detectors. Compactness, reliability and compatibility with integrated circuits keynote light-emitting diode advantages — as well as perfect spectral matching in infrared (IR) units to silicon detectors. They emit infrared or visible light when forward biased. Motorola offers a variety of red and infrared, fast switching types for flexibility in package, performance and price.

TABLE OF CONTENTS

OPTICAL COUPLERS/ISOLATORS

| | Page |
|--|-------|
| Transistor Output | |
| Popular form of isolator that offers moderate speed (approximately 300 kHz), sensitivity and economy | 4-109 |
| Darlington Output | |
| Designed for use when high transfer ratios and increased output current capability are required. The speed, approximately 30 kHz, is slower than the transistor type but the transfer ratio can be as much as twenty times as high as the single transistor type | 4-109 |
| High-Speed Logic Coupler | |
| Gallium Arsenide LED optically coupled to a high-speed integrated detector Intended for use as a digital inverter. | 4-109 |

LIGHT-EMITTING DIODES

| | |
|--|-------|
| Light-Emitting Diodes | |
| Wide variety of styles accommodate differing needs in color, viewing angle, package size, light-sensitivity and off-on contrast. | 4-110 |
| Infrared-Emitting Diodes | |
| Gallium Arsenide devices emitting in the 900 nm (9000 Å) region. This wavelength is matched to the peak sensitivity of silicon detectors | 4-111 |

SILICON PHOTO DETECTORS

| | |
|--|-------|
| Phototransistors | |
| One of the most popular detectors offers moderate sensitivity and medium speed (approximately 2.0 μ s response time). | 4-112 |
| Photodiodes | |
| Ideal for detection systems where response times on the order of 1.0 ns are required. Although output levels are low, they can easily be amplified to provide working signal levels. | 4-112 |
| Darlington | |
| These devices provide a higher degree of sensitivity for those areas that demand the extreme in this parameter. | 4-112 |

OPTOELECTRONICS (Continued)

The following index reflects the devices characterized in this section. To locate the exact page number, see Catalog Index (Page 7-1).

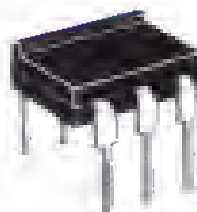
DEVICE INDEX

| | | |
|--------|---------|---------|
| 1N5909 | 4N38A | MOC5001 |
| 1N5910 | MLED50 | MOC8030 |
| 1N5911 | MLED55 | MOC8050 |
| 1N5912 | MLED60 | MRD148 |
| 2N5777 | MLED90 | MRD120 |
| 2N5778 | MLED92 | MRD121 |
| 2N5779 | MLED440 | MRD150 |
| 2N5780 | MLED445 | MRD300 |
| 4N25 | MLED500 | MRD310 |
| 4N25A | MLED600 | MRD360 |
| 4N26 | MLED840 | MRD370 |
| 4N27 | MLED855 | MRD450 |
| 4N28 | MLED660 | MRD500 |
| 4N29 | MLED900 | MRD510 |
| 4N29A | MLED910 | MRD601 |
| 4N30 | MLED930 | MRD602 |
| 4N31 | MOC119 | MRD603 |
| 4N32 | MOC1005 | MRD604 |
| 4N32A | MOC1006 | MRD810 |
| 4N33 | MOC3000 | MRD3050 |
| 4N35 | MOC3001 | MRO3051 |
| 4N36 | MOC3002 | MRD3055 |
| 4N37 | MOC3003 | MRD3056 |
| 4N38 | MOC5000 | |

OPTICAL COUPLERS/ISOLATORS

Couplers are designed to provide isolation protection from high-voltage transients, surge voltage or low level noise that would otherwise damage the input or generate erroneous information. They allow interfacing systems of different logic levels, different grounds, etc., that would otherwise be incompatible. Motorola offers a variety of standard isolation voltages from transients protection of 500 to 5000 Volts minimum.

Motorola also offers a wide array of standard devices that have a wide range of specifications (including the first series of DIP transistors and darlington couplers to achieve JEDEC registration: transistors — 4N25 thru 4N28/darlington — 4N29 thru 4N33).

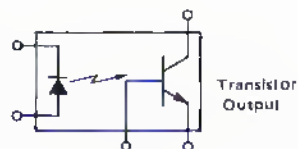


CASE 673-04



The **Transistor Coupler** is probably the most popular form of isolator since it offers moderate speed (approximately 300 kHz), sensitivity and economy. In addition, the collector-base junction can be used as a photo diode to achieve higher speeds. The output in the diode mode is lower, requiring amplification for more usable output levels.

For High Speed, Moderate Efficiency



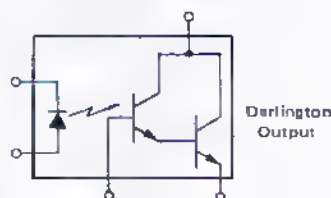
| Device Type | Isolation* Voltage Volts Min | DC Current Transfer Ratio % Min | V_{CE0} Volts Min | Collector Output Current @ $I_F = 10$ mA Typ mA |
|-------------|---------------------------------------|---|---------------------------|--|
| 4N28 | 600 | 10 | 30 | 2.0 |
| 4N25 | 1500 | 20 | 30 | 3.5 |
| 4N27 | 1500 | 10 | 30 | 2.0 |
| 4N38 | 1500 | 20 | 80 | 3.5 |
| 4N37 | 1500 | 100 | 30 | 2.0 |
| 4N36 | 2500 | 100 | 30 | 2.0 |
| 4N25 | 2500 | 20 | 30 | 3.5 |
| 4N25A** | 2500 | 20 | 30 | 3.5 |
| 4N38A** | 2500 | 20 | 80 | 3.5 |
| 4N35 | 3550 | 100 | 30 | 2.0 |
| MOC1005 | 5000 | 20 | 30 | 5.0 |
| MOC1006 | 5000 | 10 | 30 | 3.0 |

* AC peak voltage — one full sine wave 60 Hz.

** Underwriter Laboratory Recognition

The **Darlington Transistor Coupler** is used when high transfer ratios and increased output current capability are needed. The speed, approximately 30 kHz, is slower than the transistor type but the transfer ratio can be as much as twenty times as high as the single transistor type.

For High Efficiency, Moderate Speed



| Device Type | Isolation* Voltage Volts Min | DC Current Transfer Ratio % Min | V_{CEO} Volts Min | Collector Output Current @ $I_F = 10$ mA Typ mA |
|-------------------|---------------------------------------|---|---------------------------|--|
| 4N30 (MOC1200) | 1500 | 100 | | 30 |
| 4N31 | 1500 | 50 | 30 | 10 |
| 4N33 | 1500 | 500 | 30 | 60 |
| MOC119 | 1500 | 300 | 30 | 45 |
| MOC8030 | 1500 | 300 | 80 | 45 |
| MOC8050 | 1500 | 500 | 80 | 60 |
| 4N29 | 2500 | 100 | 30 | 30 |
| 4N29A** | 2500 | 100 | 30 | 30 |
| 4N32 | 2500 | 500 | 30 | 60 |
| 4N32A** | 2500 | 500 | 30 | 60 |

* AC peak voltage — one full sine wave 60 Hz.

** Underwriter Laboratory Recognition.

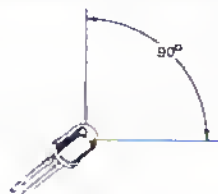
Complex Functions

As the areas of application for couplers grow, more complicated output functions will be required. Higher speeds, lower drive, more current output devices are already beginning to make their appearance on the marketplace. (Motorola now offers a high-speed function and is developing a new TRIAC Driver/Bilateral Switch function). These new functions will offer the designer even more flexibility and opportunities for creative design.



| Device Type | Isolation Voltage Volts Min | Switching Times on ns Typ off ns Typ | | Off Output Current μ A Max |
|-----------------------------------|--------------------------------------|---|------------|---|
| Hi-Speed | | | | |
| MOC5001 MOC5000 | 500 1500 | 300 250 | 650 400 | 100 100 |
| Triac Driver/ Bilateral Switch | | LEO Trigger Current $I_F(TH)$ Typ mA | | Output Saturation Current $I_{(sat)}$ Typ mA |
| MOC3000 | 5000 | 5.0 | | 80 |
| MOC3001 | 5000 | 5.0 | | 45 |
| MOC3002 | 5000 | 5.0 | | 80 |
| MOC3003 | 5000 | 5.0 | | 45 |

VISIBLE LIGHT-EMITTING DIODES

















Motorola visible emitters are available for use in panel and circuit condition indicators, light modulators, and film annotation.

Peak Emission Wavelength = 660 nm (Typ)

Forward Voltage @ 20 mA = 1.6 V (Typ) (Except as noted)

Viewing Angle — Angle at which intensity is 50% of maximum on axis intensity.

| Package | Device Type (Lens Type) | Viewing Angle α | Instantaneous Axial Luminous Intensity Typical | Mounting | |
|--|---|-----------------------|--|----------|------------------|
| | | | | Panel | Circuit Board |
|  Case 279-01 Plastic  Actual Size | 1N5911 (Note 1,2,3) (Formerly MLED750) (Diffusing Green) | 90° | 0.3 @ 25 mA | x | |
| | 1N5912 (Note 1,2,4) (Formerly MLED850) (Visible Yellow) | 90° | 0.3 @ 25 mA | x | |
|  Case 171 (2) Plastic  Actual Size | MLED600 (Clear Red) | 30° | 3.0 @ 20 mA | x | x |
|  Case 234-02 Plastic  Actual Size | MLED50 (Clear) | 70° | 1.0 @ 20 mA | x | x |
| | MLED55 (Diffusing Red) | 100° | 0.6 @ 20 mA | x | x |
|  Case 279-01 Plastic  Actual Size | MLED640 (Milky White) | 90° | 2.0 @ 20 mA | x | |
| | MLED655 (Diffusing Red) General Purpose | 90° | 2.0 @ 20 mA | x | |
| | MLED660 (Diffusing Red) High Current | 90° | 1.5 @ 20 mA | x | |
|  Case 292-01 Plastic  Actual Size | MLED440 (Visible Red) | 90° | 0.3 @ 20 mA | x | |
| | MLED445 (Clear) | 40° | 0.8 @ 20 mA | x | |
| | 1N5909 (Formerly MLED455) (Diffusing Red) | 75° | 1.2 @ 20 mA | x | |
|  Case 279-01 Plastic  Actual Size | 1N5910 (Formerly MLED650) (Diffusing Red) Wide Viewing | 140° | 0.8 @ 20 mA | x | |
|  Case 29-02 Plastic  Actual Size | MLED500 (Diffusing Red) | 110° | 0.3 @ 20 mA | | x |

- Notes: 1. Indicates JEDEC Registered Data
 2. Forward Voltage @ 25 mA = 2.1 V (Typ)
 3. Peak Emission Wavelength = 660 nm (Typ)
 4. Peak Emission Wavelength = 575 nm (Typ)

INFRARED-EMITTING DIODES






Infrared (900 nm) gallium arsenide emitters are available from Motorola for use in light modulators, shaft or position encoders, punched card and tape readers, optical switching and logic circuits. They are spectrally matched for use with silicon detectors.

Peak Emission Wavelength = 900 nm (Typ)

Forward Voltage @ 50 mA = 1.2 (Typ)



Emission Angle — Angle at which I_R emission is 50% of maximum intensity.




| Package | Device Type | Emission Angle α | Instantaneous Power Output Typ μ W | Mounting | |
|--|------------------|----------------------------|---|----------|---------------|
| | | | | Panel | Circuit Board |
|  <p>Case 81A-01 Metal</p> <p>Actual Size</p> | MLE0910 | 30° | 150 @ 60 mA | | x |
|  <p>Case 209-01 Metal</p> <p>Actual Size</p> | MLED930 | 30° | 650 @ 100 mA | x | |
|  <p>Case 171 (2) Plastic</p> <p>Actual Size</p> | MLE0900 | 30° | 550 @ 50 mA | x | x |
|  <p>Case 234-02 Clear Plastic</p> <p>Actual Size</p> | MLE080 MLE090 | 65° 65° | 550 @ 50 mA 350 @ 50 mA | x x | x x |
|  <p>Case 29-02 Plastic</p> <p>Actual Size</p> | MLED92 | 110° | 650 @ 100 mA | x | x |

PHOTODETECTORS









A variety of silicon photodetectors are available for a wide range of light detecting applications. Devices are available in packages offering choices of viewing angle and size in either low cost, economical, plastic cases or rugged, hermetic, metal cans. Advantages over phototubes are high sensitivity, good temperature stability, and proven silicon reliability. Applications include card and tape readers, pattern and character recognition, shaft encoders, position sensors, counters, and others. Maximum sensitivity occurs at approximately 800 nm.

Phototransistors

Phototransistors are used where moderate sensitivity and medium speed (2.0 μ s) are required.





| Package | Type Number | Light Current @ I_H | | BV_{CEO} Volts Min | Dark Current @ V_{CC} | |
|--|-------------|--------------------------|--------------------|----------------------------|----------------------------|-------|
| | | Typ mA | mW/cm ² | | nA Max | Volts |
|  <p>Case 210-01 Metal</p> <p>Actual Size</p> | MRO810 | 4.0 | 5.0 | 35 | 50 | 20 |
|  <p>Case 81A-01 Metal</p> <p>Actual Size</p> | MRO604 | 8.5 | 20 | 60 | 25 | 30 |
| | MRD603 | 6.0 | 20 | 60 | 25 | 30 |
| | MRO602 | 3.6 | 20 | 60 | 25 | 30 |
| | MRD601 | 1.5 | 20 | 60 | 25 | 30 |
|  <p>Case 82-01 Metal</p> <p>Actual Size</p> | MRD310 | 2.5 | 5.0 | 50 | 25 | 20 |
| | MRD300 | 7.5 | 5.0 | 50 | 25 | 20 |

Phototransistors (continued)

| Package | Type Number | Light Current @ H | | BV _{CEO} Volts Min | Dark Current @ V _{CC} | |
|--|-------------|-------------------------|--------------------|-----------------------------------|--------------------------------------|-------|
| | | Typ mA | mW/cm ² | | nA Max | Volts |
|  Case 82-01 Metal Actual Size  | MRD3054 | 1.2 | 5.0 | 30 | 100 | 20 |
| | MRD3056 | 2.6 | 5.0 | 30 | 100 | 20 |
| | MRD3055 | 1.8 | 5.0 | 30 | 100 | 20 |
| | MRD3051 | 0.2 | 5.0 | 30 | 100 | 20 |
| | MRD3050 | 0.2 | 5.0 | 30 | 100 | 20 |
| | MRD3052 | 0.25 | 5.0 | 30 | 100 | 20 |
| | MRD3053 | 0.6 | 5.0 | 30 | 100 | 20 |
|  Case 279-01 Plastic Actual Size  | MRD120 | 0.7 | 1.0 | 40 | 100 | 20 |
| | MRD121 | 0.25 | 1.0 | 40 | 100 | 20 |
|  Case 173 Clear Plastic Actual Size  | MRD150 | 0.45 | 5.0 | 40 | 100 | 20 |
|  Case 171-01 Plastic Actual Size  | MRD450 | 4.0 | 5.0 | 40 | 100 | 20 |





Photodiodes

Photodiodes are used where high speed is required (1.0 ns).

| Package | Type Number | Light Current @ H | | BV _R Volts Min | Dark Current @ V _{CC} | |
|--|-------------|-------------------------|--------------------|---------------------------------|--------------------------------------|-------|
| | | Typ μ A | mW/cm ² | | nA Max | Volts |
|  Case 209-01 Metal Convex Lens Actual Size  | MRD500 | 9.0 | 5.0 | 100 | 2.0 | 20 |
|  Case 210-01 Metal Flat Lens Actual Size  | MRD510 | 2.0 | 5.0 | 100 | 2.0 | 20 |

Photodarlington

Photodarlington are used where maximum sensitivity is required with typical rise and fall times of 50 μ s.

| Package | Type Number | Light Current @ H | | BV _{CEO} Volts Min | Dark Current @ V _{CC} | |
|---|-------------|-------------------------|--------------------|-----------------------------------|--------------------------------------|-------|
| | | Typ mA | mW/cm ² | | nA Max | Volts |
|  Case 82-01 Metal Actual Size  | MRD360 | 20 | 0.5 | 40 | 100 | 10 |
| | MRD370 | 10 | 0.5 | 40 | 100 | 10 |
|  Case 29-01 Plastic Actual Size  | 2N5760 | 8.0 | 2.0 | 40 | 100 | 12 |
| | 2N5779 | 8.0 | 2.0 | 25 | 100 | 12 |
| | 2N5778 | 4.0 | 2.0 | 40 | 100 | 12 |
| | 2N5777 | 4.0 | 2.0 | 25 | 100 | 12 |
| | MRD14B | 2.0 | 2.0 | 12 | 100 | 12 |
| | | | | | | |



CHIPS

Motorola has made available to the hybrid circuit manufacturer, in chip form, virtually all of the thousands of discrete and integrated circuit devices in its standard product catalog. For more detailed information on these chips, including testing, visual inspection, packaging, size, geometry, and metallization, contact your nearest Motorola representative or distributor.

DEVICES FOR MILITARY

APPLICATIONS



The following tables list devices that appear in QPL-19500 (Qualified Products List) as of 16 September 1975 and are available in the JAN, JANTX, and JANTXV versions as specified. Check with your local Motorola sales office or franchised distributor for current qualification status and availability.

1N...Device Numbers ASSEMBLIES DIODES

Reference
Zener
Current Regulator
Voltage Regulator

RECTIFIERS

SILICON ZENER DIODES $\pm 5\%$ SERIES

MIL-S-19500/127

1N746A JAN,JTX,JTXV thru 1N759A JAN,JTX,JTXV

MIL-S-19500/117

1N962B JAN,JTX,JTXV thru 1N992B JAN,JTX,JTXV

*MIL-S-19500/114

1N2804B JAN,JTX thru 1N2811B JAN,JTX

1N2813B JAN,JTX

1N2814B JAN,JTX

1N2816B JAN,JTX

1N2818B JAN,JTX thru 1N2820B JAN,JTX

1N2822B JAN,JTX thru 1N2827B JAN,JTX

1N2829B JAN,JTX

1N2831B JAN,JTX thru 1N2838B JAN,JTX

1N2840B JAN,JTX thru 1N2846 JAN,JTX

*MIL-S-18500/124

1N2970B JAN,JTX thru 1N2977B JAN,JTX

1N2979B JAN,JTX

1N2980B JAN,JTX

1N2982B JAN,JTX

1N2984B JAN,JTX thru 1N2986B JAN,JTX

1N2988B JAN,JTX thru 1N2993B JAN,JTX

1N2995B JAN,JTX

1N2997B JAN,JTX

1N2999B JAN,JTX thru 1N3005B JAN,JTX

1N3007B JAN,JTX thru 1N3009B JAN,JTX

1N3011B JAN,JTX

1N3012B JAN,JTX

1N3014B JAN,JTX

1N3015B JAN,JTX

MIL-S-19500/115

1N3016B JAN,JTX,JTXV thru 1N3051B JAN,JTX,JTXV

SILICON ZENER DIODES $\pm 5\%$ SERIES (continued)

*MIL-S-19500/358

1N3305B JAN,JTX thru 1N3312B JAN,JTX

1N3314B JAN,JTX

1N3315B JAN,JTX

1N3317B JAN,JTX

1N3319B JAN,JTX thru 1N3321B JAN,JTX

1N3323B JAN,JTX thru 1N3328B JAN,JTX

1N3330B JAN,JTX

1N3332B JAN,JTX

1N3334B JAN,JTX thru 1N3340B JAN,JTX

1N3342B JAN,JTX thru 1N3344B JAN,JTX

1N3346B JAN,JTX

1N3347B JAN,JTX

1N3349B JAN,JTX

1N3350B JAN,JTX

MIL-S-19500/115

1N3821A JAN,JTX,JTXV thru 1N3828A JAN,JTX,JTXV

**MIL-S-19500/272

1N3993A JAN,JTX thru 1N4000A JAN,JTX

MIL-S-19500/435

1N4099 JAN,JTX,JTXV thru 1N4135 JAN,JTX,JTXV

MIL-S-19500/127

1N4370A JAN,JTX,JTXV thru 1N4372A JAN,JTX,JTXV

*MIL-S-19500/358

1N4549B JAN,JTX thru 1N4554B JAN,JTX

MIL-S-18500/435

1N4614 JAN,JTX,JTXV thru 1N4627 JAN,JTX,JTXV

MIL-S-19500/73

1N4557B RB,JAN,JTX thru 1N4562B JAN,JTX

VOLTAGE REGULATORS

MIL-S-19500/437

1N5519B JAN,JANTX thru 1N5545B JAN,JANTX

DEVICES FOR MILITARY APPLICATIONS (continued)

1N... DEVICE NUMBERS (continued)

CURRENT REGULATORS

MIL-S-19500/463

| | |
|---------------------|---------------------|
| 1N5285 JAN,JTX,JTXV | 1N5300 JAN,JTX,JTXV |
| 1N5286 JAN,JTX,JTXV | 1N5301 JAN,JTX,JTXV |
| 1N5287 JAN,JTX,JTXV | 1N5302 JAN,JTX,JTXV |
| 1N5288 JAN,JTX,JTXV | 1N5303 JAN,JTX,JTXV |
| 1N5289 JAN,JTX,JTXV | 1N5304 JAN,JTX,JTXV |
| 1N5290 JAN,JTX,JTXV | 1N5305 JAN,JTX,JTXV |
| 1N5291 JAN,JTX,JTXV | 1N5306 JAN,JTX,JTXV |
| 1N5292 JAN,JTX,JTXV | 1N5307 JAN,JTX,JTXV |
| 1N5293 JAN,JTX,JTXV | 1N5308 JAN,JTX,JTXV |
| 1N5294 JAN,JTX,JTXV | 1N5309 JAN,JTX,JTXV |
| 1N5295 JAN,JTX,JTXV | 1N5310 JAN,JTX,JTXV |
| 1N5296 JAN,JTX,JTXV | 1N5311 JAN,JTX,JTXV |
| 1N5297 JAN,JTX,JTXV | 1N5312 JAN,JTX,JTXV |
| 1N5298 JAN,JTX,JTXV | 1N5313 JAN,JTX,JTXV |
| 1N5299 JAN,JTX,JTXV | 1N5314 JAN,JTX,JTXV |

TC REFERENCE DIODES

MIL-S-19500

| | |
|---------------------------|------|
| 1N429 JAN | /299 |
| 1N821 JAN,JTX,JTXV | /159 |
| 1N823 JAN,JTX,JTXV | /159 |
| 1N825 JAN,JTX,JTXV | /159 |
| 1N827 JAN,JTX,JTXV | /159 |
| 1N829 JAN,JTX,JTXV | /159 |
| 1N9358 JAN,JTX,JTXV | /156 |
| 1N9378 JAN,JTX,JTXV | /156 |
| 1N9388 JAN,JTX,JTXV | /156 |
| 1N9398 JAN,JTX,JTXV | /156 |
| 1N9418 JAN,JTX | /157 |
| 1N9438 JAN,JTX | /157 |
| 1N9448 JAN,JTX | /157 |
| 1N9458 JAN,JTX | /157 |
| 1N3154 JAN,JTX | /158 |
| 1N3155 JAN,JTX | /158 |
| 1N3156 JAN,JTX | /158 |
| 1N3157 JAN,JTX | /158 |
| 1N4565A JAN,JTX,JTXV thru | /452 |
| 1N4574A JAN,JTX,JTXV | |

DIODE ASSEMBLIES

MIL-S-19500

| | |
|-------------|------|
| 1N1530A JAN | /320 |
| 1N1742A JAN | /298 |

RECTIFIERS

MIL-S-19500/304

| |
|----------------------|
| 1N3890 JAN,JTX,JTXV |
| 1N3890R JAN,JTX,JTXV |
| 1N3891 JAN,JTX,JTXV |
| 1N3891R JAN,JTX,JTXV |
| 1N3893 JAN,JTX,JTXV |
| 1N3893R JAN,JTX,JTXV |

MIL-S-19500/308

| |
|-----------------|
| 1N3910R JAN,JTX |
| 1N3911R JAN,JTX |
| 1N3912R JAN,JTX |
| 1N3913R JAN,JTX |

DEVICES FOR MILITARY APPLICATIONS (continued)

2N... Device Numbers

TRANSISTORS

Field Effect, High Frequency,
Multiple Device, Power, RF Power,
Switching and Unijunction

THYRISTORS

The following tables list devices that appear in QPL-19500 (Qualified Products List) as of 16 September 1975 and are available in the JAN, JANTX, and JANTXV versions as specified. Check with your local Motorola sales office or franchised distributor for current qualification status and availability.

SWITCHING AND HIGH FREQUENCY TRANSISTORS

MIL-S-19500

| | | | |
|----------------------|------|----------------------|------|
| 2N499 JAN | /172 | 2N3250A JAN,JTX,JTXV | /323 |
| 2N499A JAN | /172 | 2N3251A JAN,JTX,JTXV | /323 |
| 2N502A JAN | /112 | 2N3253 JAN | /347 |
| 2N502B JAN | /112 | 2N3253S JAN | /347 |
| 2N703 JAN | /153 | 2N3444 JAN | /347 |
| 2N705 JAN | /86 | 2N3444S JAN | /347 |
| 2N706 JAN | /120 | 2N3449 JAN | /338 |
| 2N708 JAN,JTX | /312 | 2N3467 JAN,JTX,JTXV | /348 |
| 2N718A JAN,JTX,JTXV | /181 | 2N3468 JAN,JTX,JTXV | /348 |
| 2N869A JAN,JTX | /283 | 2N3485A JAN,JTX | /392 |
| 2N914 JAN,JTX | /373 | 2N3486A JAN,JTX | /392 |
| 2N916 JAN | /271 | 2N3498 JAN,JTX,JTXV | /366 |
| 2N929 JAN,JTX | /253 | 2N3499 JAN,JTX,JTXV | /366 |
| 2N930 JAN,JTX | /253 | 2N3500 JAN,JTX,JTXV | /366 |
| 2N962 JAN | /258 | 2N3501 JAN,JTX,JTXV | /366 |
| 2N964 JAN | /258 | 2N3506 JAN,JTX,JTXV | /349 |
| 2N1132 JAN | /177 | 2N3507 JAN,JTX,JTXV | /349 |
| 2N1613 JAN,JTX,JTXV | /181 | 2N3634 JAN,JTX,JTXV | /357 |
| 2N2218 JAN,JTX,JTXV | /251 | 2N3635 JAN,JTX,JTXV | /357 |
| 2N2218A JAN,JTX,JTXV | /251 | 2N3636 JAN,JTX,JTXV | /357 |
| 2N2219 JAN,JTX,JTXV | /251 | 2N3637 JAN,JTX,JTXV | /357 |
| 2N2219A JAN,JTX,JTXV | /251 | 2N3743 JAN,JTX,JTXV | /397 |
| 2N2221 JAN,JTX,JTXV | /255 | 2N3762 JAN,JTX,JTXV | /396 |
| 2N2221A JAN,JTX,JTXV | /255 | 2N3763 JAN,JTX,JTXV | /396 |
| 2N2222 JAN,JTX,JTXV | /255 | 2N3764 JAN,JTX,JTXV | /396 |
| 2N2222A JAN,JTX,JTXV | /255 | 2N3765 JAN,JTX,JTXV | /396 |
| 2N2369A JAN,JTX,JTXV | /317 | 2N3959 JAN,JTX | /399 |
| 2N2481 JAN,JTX | /268 | 2N3960 JAN,JTX | /399 |
| 2N2857 JAN,JTX,JTXV | /343 | 2N4405 JAN,JTX | /448 |
| 2N2905 JAN,JTX,JTXV | /290 | 2N4449 JAN,JTX,JTXV | /317 |
| 2N2905A JAN,JTX,JTXV | /290 | 2N4453 JAN,JTX | /283 |
| 2N2906 JAN,JTX,JTXV | /291 | 2N4930 JAN,JTX,JTXV | /397 |
| 2N2906A JAN,JTX,JTXV | /291 | 2N4931 JAN,JTX,JTXV | /397 |
| 2N2907 JAN,JTX,JTXV | /291 | 2N5581 JAN,JTX | /423 |
| 2N2907A JAN,JTX,JTXV | /291 | 2N5582 JAN,JTX | /423 |
| 2N3013 JAN,JTX | /287 | 2N6365 JAN | /471 |
| | | 2N6365A JAN | /471 |

POWER TRANSISTORS

MIL-S-19500

| | | | |
|---------------------|------|---------------------|------|
| 2N3715 JAN,JTX,JTXV | /408 | 2N3868 JAN,JTX,JTXV | /350 |
| 2N3716 JAN,JTX,JTXV | /408 | 2N3902 JAN,JTX | /371 |
| 2N3739 JAN,JTX | /402 | 2N4399 JAN,JTX,JTXV | /433 |
| 2N3740 JAN,JTX,JTXV | /441 | 2N5302 JAN,JTX | /456 |
| 2N3741 JAN,JTX,JTXV | /441 | 2N5303 JAN,JTX | /456 |
| 2N3791 JAN,JTX,JTXV | /379 | 2N5685 JAN,JTX,JTXV | /464 |
| 2N3792 JAN,JTX,JTXV | /379 | 2N5686 JAN,JTX,JTXV | /464 |
| 2N3867 JAN,JTX,JTXV | /350 | 2N5745 JAN,JTX,JTXV | /433 |

DEVICES FOR MILITARY APPLICATIONS (continued)

2N... DEVICE NUMBERS (continued)

SILICON CONTROLLED RECTIFIERS

MIL-S-19500

| | |
|------------|------|
| 2N4199 JAN | /372 |
| 2N4200 JAN | /372 |
| 2N4201 JAN | /372 |
| 2N4202 JAN | /372 |
| 2N4203 JAN | /372 |
| 2N4204 JAN | /372 |

MULTIPLE DEVICES

MIL-S-19500

| | |
|---------------------|------|
| 2N2060 JAN,JTX,JTXV | /270 |
| 2N3810 JAN,JTX,JTXV | /336 |
| 2N3811 JAN,JTX,JTXV | /336 |
| 2N4854 JAN,JTX,JTXV | /421 |
| 2N5793,94 JAN,JTX | /495 |

UNI-JUNCTION

MIL-S-19500

| | |
|----------------|------|
| 2N4948 JAN,JTX | /388 |
| 2N4949 JAN,JTX | /388 |
| 2N5431 JAN,JTX | /425 |
| 2N6116 JAN,JTX | /493 |
| 2N6117 JAN,JTX | /493 |
| 2N6118 JAN,JTX | /493 |

FIELD-EFFECT TRANSISTORS

MIL-S-19500

| | |
|-------------------|------|
| 2N3330 JAN,JTX | /378 |
| 2N3821 JAN,JTX | /375 |
| 2N3822 JAN,JTX | /375 |
| 2N3823 JAN,JTX | /375 |
| 2N4856,59 JAN,JTX | /385 |

RF POWER TRANSISTORS

MIL-S-19500

| | |
|----------------------|------|
| 2N918 JAN,JTX,JTXV | /301 |
| 2N1142 JAN | /87 |
| 2N1195 JAN | /71 |
| 2N2273 JAN | /244 |
| 2N3127 JAN | /346 |
| 2N3375 JAN,JTX,JTXV | /341 |
| 2N3553 JAN,JTX,JTXV | /341 |
| 2N3866 JAN,JTX,JTXV | /398 |
| 2N3866A JAN,JTX,JTXV | /398 |

The following tables list devices which are in the process of qualification for listing in QPL-19500 as of 16 September 1975. Check with your local Motorola sales office or franchised distributor for current qualification status and availability.

POWER TRANSISTORS

MIL-S-19500

| | |
|------------------------|------|
| 2N3439,40 JAN,JTX | /368 |
| 2N5664,65 JAN,JTX,JTXV | /455 |
| 2N5683,84 JAN,JTX | /466 |
| 2N6051,52 JAN,JTX,JTXV | /501 |
| 2N6058,59 JAN,JTX,JTXV | /503 |
| 2N6306,08 JAN,JTX | /498 |

SWITCHING AND HIGH FREQUENCY TRANSISTORS

MIL-S-19500

| | |
|------------------------|------|
| 2N3019 JAN,JTX | /391 |
| 2N3700 JAN,JTX | /391 |
| 2N3735,37 JAN,JTX,JTXV | /395 |
| 2N4957 JAN,JTX | /426 |
| 2N5109 JAN,JTX | /453 |

MULTIPLE DEVICES

MIL-S-19500

| | |
|------------------------|------|
| 2N5795,96 JAN,JTX,JTXV | /496 |
|------------------------|------|

FIELD-EFFECT TRANSISTORS

MIL-S-19500

| | |
|-------------------------|------|
| 2N4092 JAN,JTX | /431 |
| 2N4093 JAN,JTX | /431 |
| 2N4416A JAN,JTX,JTXV | /428 |
| 2N4857,58,60,61 JAN,JTX | /385 |

INTEGRATED CIRCUITS

A typical military part number consists of the JAN prefix, the general specification number, the detail specification number, and a coded part number.

PART NUMBER DESCRIPTION

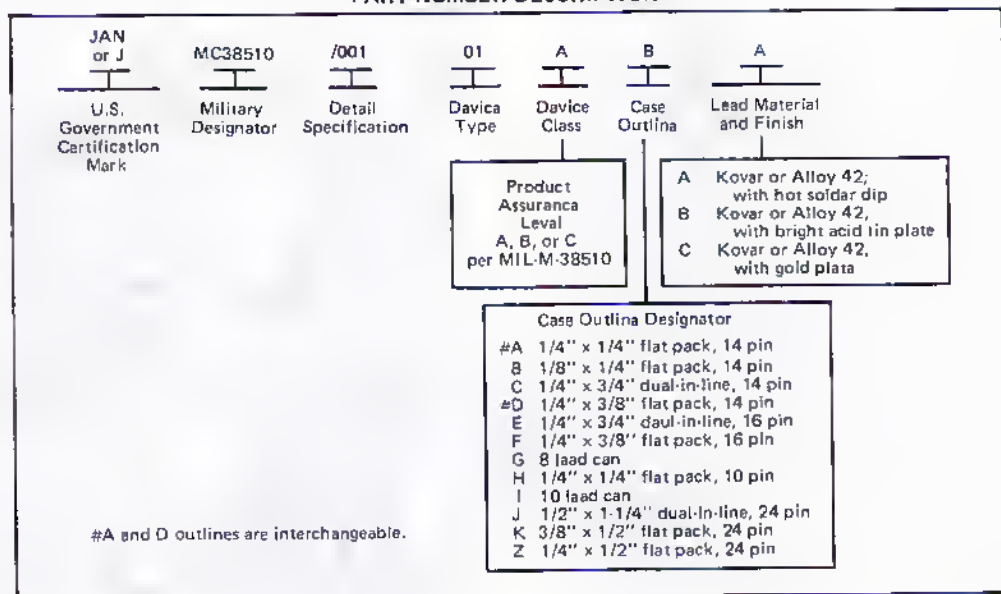


TABLE I — JAN PART NUMBER TO MOTOROLA PART NUMBER CROSS REFERENCE

Contact your local Motorola sales office or franchised distributor for current qualification status and availability.

| MTTL INTEGRATED CIRCUITS | | | | | | | | | |
|-------------------------------|----------------------------|--|----------------------------|--|----------------------------|------------------------------------|----------------------------|-----------------------------|----------------------------|
| JAN Part No.** | Motorola Standard Part No. | JAN Part No.** | Motorola Standard Part No. | JAN Part No.** | Motorola Standard Part No. | JAN Part No.** | Motorola Standard Part No. | JAN Part No.** | Motorola Standard Part No. |
| MIL-M-38510/001 NAND Gates | | MIL-M-38510/003 NAND Buffers | | MIL-M-38510/006 Binary Full Adders | | MIL-M-38510/009 Shift Registers | | | |
| 01 | MC5430 | 01 | MC5440 | 01 | MC15482 | 01 | MC5495 | 02 | MC5496 |
| 02 | MC5420 | 02 | MC5437 | 02 | MC5483 | 03 | MC54164A | 03 | MC54165 |
| 03 | MC5410 | 03 | MC543B | 03 | MC9304 | 04 | MC54194 | 04 | MC54195 |
| 04 | MC5400 | MIL-M-38510/004 NOR Gates | | MIL-M-38510/007 Exclusive OR Gate | | 05 | MC54195 | MIL-M-38510/010 Decoders | |
| 05 | MC5404 | 01 | MC5402 | 01 | MC5486 | 01 | MC5442 | 02 | MC5443 |
| 06 | MC5412 | 02 | MC5423 | MIL-M-38510/008 Hex Buffers/Drivers | | 02 | MC5443 | 03 | MC5444 |
| 07 | MC5401 | 03 | MC5425 | 01 | MC5406 | 03 | MC5444 | 04 | MC5445 |
| 08 | MC5405 | 04 | MC5427 | 02 | MC5416 | 04 | MC5445 | 05 | MC54145 |
| 09 | MC5403 | MIL-M-38510/005 AND-OR-INVERT Gates | | 03 | MC5407 | 05 | MC5446 | 06 | MC5446 |
| MIL-M-38510/002 Flip-Flops | | 01 | MC5450 | 04 | MC5417 | 07 | MC5447 | 07 | MC5447 |
| 01 | MC5472 | 02 | MC5451 | 05 | MC5426 | 08 | MC5448 | 08 | MC5448 |
| 02 | MC5473 | 03 | MC5453 | | | 09 | MC5449 | 09 | MC5449 |
| 03 | MC54107 | 04 | MC5454 | | | | | | |
| 04 | MC5476 | | | | | | | | |
| 05 | MC5474 | | | | | | | | |
| 06 | MC5470 | | | | | | | | |
| 07 | MC5479 | | | | | | | | |

**JAN type number must be completed as shown in the Part Number Description.

TABLE I — JAN PART NUMBER TO MOTOROLA PART NUMBER
CROSS REFERENCE (continued)

MTTL INTEGRATED CIRCUITS (continued)

| JAN Part No.** | Motorola Standard Part No. | JAN Part No.** | Motorola Standard Part No. | JAN Part No.** | Motorola Standard Part No. | JAN Part No.** | Motorola Standard Part No. |
|--|----------------------------|---|----------------------------|--|----------------------------|---|----------------------------|
| MIL-M-38510/011 Arithmetic Logic Unit | | MIL-M-38510/015 Bistable Latches | | MIL-M-38510/022 High-Speed Flip-Flops | | MIL-M-38510/027 Low-Power NOR Gats | |
| 01 | MC54181 | 01 | MC5475 | 01 | MC54H72 | 01 | MC54L02* |
| 02 | MC54182 | 02 | MC5477 | 02 | MC54H73 | MIL-M-38510/028 Low-Power Shift Registers | |
| MIL-M-38510/012 Monostable Multivibrators | | 03 | MC9308 | 03 | MC54H74A | 01 | MC54L95* |
| 01 | MC54121 | 04 | MC9314 | 04 | MC54H76 | 02 | MC54L164* |
| 02 | MC54122 | MIL-M-38510/016 AND Gates | | 05 | MC54H101 | MIL-M-38510/029 Low-Power Decoders | |
| 03 | MC54123 | 01 | MC5408 | 06 | MC54H103 | 01 | MC54L42* |
| MIL-M-38510/013 Counters | | 02 | MC5409 | MIL-M-38510/023 High-Speed NAND Gates | | 02 | MC54L43* |
| 01 | MC5492 | MIL-M-38510/017 Low-Power Flip-Flops | | 01 | MC54H30 | 03 | MC54L44* |
| 02 | MC5493 | 01 | MC54174 | 02 | MC54H20 | 04 | MC54L46* |
| 03 | MC54160 | 02 | MC54175 | 03 | MC54H10 | 05 | MC54L47* |
| 04 | MC54163 | MIL-M-38510/018 Parity Generators/Checkers | | 04 | MC54H00 | MIL-M-38510/040 High-Speed AND-OR-INVERT Gates | |
| 05 | MC54162 | 01 | MC54180 | 05 | MC54H04 | 01 | MC54H50 |
| 06 | MC54161 | MIL-M-38510/020 Low-Power NAND Gates | | 06 | MC54H01 | 02 | MC54H51 |
| 07 | MC5490 | 01 | MC54L30* | 07 | MC54H22 | 03 | MC54H53 |
| 08 | MC54192 | 02 | MC54L20* | MIL-M-38510/024 High-Speed NAND Buffer | | 04 | MC54H54 |
| 09 | MC54193 | 03 | MC54L10* | 01 | MC54H40 | 05 | MC54H55 |
| MIL-M-38510/014 Data Selectors/Multiplexers | | 04 | MC54L00* | MIL-M-38510/025 Counters | | MIL-M-38510/041 Low-Power AND-OR-INVERT Gates | |
| 01 | MC54150 | 05 | MC54L04* | 01 | MC54L90* | 01 | MC54L51* |
| 02 | MC9312 | 06 | MC54L03* | 02 | MC54L93* | 02 | MC54L54* |
| 03 | MC54153 | MIL-M-38510/021 Low-Power Flip-Flops | | MIL-M-38510/026 Low-Power Exclusive OR Gats | | 03 | MC54L55* |
| 04 | MC9309 | 01 | MC54L71* | 01 | MC54L86* | MIL-M-38510/151 Schmitt Triggers | |
| 05 | MC9322 | 02 | MC54L72* | | | 01 | MC5413 |
| 06 | MC54151 | 03 | MC54L73* | | | 02 | MC5414 |
| | | 04 | MC54L78* | | | 03 | MC54132 |
| | | 05 | MC54L74* | | | | |

MDTL INTEGRATED CIRCUITS

| JAN Part No.** | Motorola Standard Part No. | JAN Part No.** | Motorola Standard Part No. | JAN Part No.** | Motorola Standard Part No. | JAN Part No.** | Motorola Standard Part No. |
|-------------------------------|----------------------------|---|----------------------------|---|----------------------------|-------------------------------|----------------------------|
| MIL-M-38510/030 NAND Gates | | MIL-M-38510/031 NAND Buffer/Expander | | MIL-M-38510/032 Monostable Multivibrator | | MIL-M-38510/033 Flip-Flops | |
| 01 | MC930 | 01 | MC932 | 01 | MC951 | 01 | MC945 |
| 02 | MC935 | 02 | MC944 | | | 02 | MC948 |
| 03 | MC936 | 03 | MC957 | | | 03 | MC950 |
| 04 | MC946 | 04 | MC958 | | | 04 | MC9093** |
| 05 | MC962 | 05 | MC933 | | | | |

*Not presently being manufactured or planned for immediate introduction.

**JAN type number must be completed as shown in the Part Number Description.

TABLE I - JAN PART NUMBER TO MOTOROLA PART NUMBER
CROSS REFERENCE (continued)

| MCMOS INTEGRATED CIRCUITS | | | | | | | |
|--|----------------------------|--|--|----------------------------|--|---|----------------------------|
| JAN Part No.** | Motorola Standard Part No. | | JAN Part No.** | Motorola Standard Part No. | | JAN Part No.** | Motorola Standard Part No. |
| MIL-M-38510/050 NAND Gates | | | MIL-M-38510/052 NOR Gates | | | MIL-M-38510/055 Buffers/Converters | |
| 01 | MC14011A | | 01 | MC14000A | | 01 | MC1409A |
| 02 | MC14012A | | 02 | MC14001A | | 02 | MC14010A |
| 03 | MC14023A | | 03 | MC14002A | | 03 | MC14049A |
| MIL-M-38510/051 Flip-Flops | | | 04 | MC14025A | | 04 | MC14050A |
| 01 | MC14013A | | MIL-M-38510/053 AND-OR-INVERT Gates | | | 05 | MC14041A* |
| 02 | MC14027A | | 01 | MC14007A | | MIL-M-38510/056 Counters/Dividers | |
| | | | 02 | MC14019A* | | 01 | MC14017A |
| | | | 03 | MC14030A* | | 02 | MC14018A* |
| | | | MIL-M-38510/054 4-Bit Full Adder | | | 03 | MC14020A |
| | | | 01 | MC14008A | | 04 | MC14022A |
| | | | | | | 05 | MC14024A |
| | | | | | | MIL-M-38510/057 Static Shift Registers | |
| | | | | | | 01 | MC14006A |
| | | | | | | 02 | MC14014A* |
| | | | | | | 03 | MC14015A |
| | | | | | | 04 | MC14021A |
| | | | | | | 05 | MC14031A* |
| | | | | | | MIL-M-38510/058 Quad Analog Switch | |
| | | | | | | 01 | MC14016A |
| MECL 10,000 INTEGRATED CIRCUITS | | | | | | | |
| JAN Part No.** | Motorola Standard Part No. | | | | | | |
| MIL-M-38510/060# Multiple Gates | | | | | | | |
| 01 | MC10501 | | | | | | |
| 02 | MC10502 | | | | | | |
| 03 | MC10505 | | | | | | |
| 04 | MC10506 | | | | | | |
| 05 | MC10507 | | | | | | |
| 06 | MC10509 | | | | | | |
| 07 | MC10504 | | | | | | |
| LINEAR INTEGRATED CIRCUITS | | | | | | | |
| JAN Part No.** | Motorola Standard Part No. | | JAN Part No.** | Motorola Standard Part No. | | JAN Part No.** | Motorola Standard Part No. |
| MIL-M-38510/101 Operational Amplifiers | | | MIL-M-38510/102 Voltage Regulator | | | MIL-M-38510/104 Line Drivers and Receivers | |
| 01 | MC1741 | | 01 | MC1723 | | 01 | MC55107 |
| 02 | MC1747 | | MIL-M-38510/103 Voltage Comparators | | | 02 | MC55108 |
| 03 | MLM101A | | 01 | MC1710 | | 03 | MC9614* |
| 04 | MLM108A | | 02 | MC1711 | | 04 | MC9615* |
| 05 | MLH2101A* | | 03 | MLM106* | | 05 | MC55113* |
| 06 | MLH2108A* | | 04 | MLM111* | | MIL-M-38510/107 Voltage Regulator | |
| 07 | MLM118* | | | | | 01 | MLM109 |
| MEMORIES | | | | | | | |
| JAN Part No.** | Motorola Standard Part No. | | | | | | |
| MIL-M-38510/201 Programmable Read Only Memories | | | | | | | |
| 01 | MCM5303 | | | | | | |
| 02 | MCM5304 | | | | | | |

* Not presently being manufactured or planned for immediate introduction.

* JAN type number must be completed as shown in the Part Number Description.

#A draft of MIL-M-38510/060 has been issued. A series of MIL-M-38510 specifications has been reserved for the complete line of MECL devices including flip-flops, decoders, and arithmetic units.



APPLICATION NOTES

The Application Notes listed have been prepared to acquaint the circuits and systems engineer with the broad line of Motorola Semiconductor Products and their applications.

To obtain copies of these notes, simply list the AN number or numbers and send your request on your company letterhead to: Technical Information Center, Motorola Semiconductor Products Inc., P. O. Box 20912, Phoenix, Arizona 85036.

APPLICATION NOTE NUMBER TITLE

| | |
|---------|---|
| AN-139A | Understanding Transistor Response Parameters |
| AN-178A | Epicap Tuning Diode Theory and Applications |
| AN-182 | A Method of Predicting Thermal Stability |
| AN-189 | Solid-State Pulse Width Modulation DC Motor Control |
| AN-204A | The MC1530, MC1531 Integrated Operational Amplifiers |
| AN-210 | FM Modulation Capabilities of Epicap VV C's |
| AN-211A | Field-Effect Transistors in Theory and Practice |
| AN-215A | RF Small-Signal Design Using 2-Port Parameters |
| AN-219 | The Field-Effect Transistor in Digital Applications |
| AN-220 | FET's in Chopper and Analog Switching Circuits |
| AN-221 | 4-Layer and Current-Limiter Diodes Reduce Circuit Cost and Complexity |
| AN-222 | The ABC's of Solid-State DC to AC Inverters |
| AN-238 | Transistor Mixer Design Using 2-Port Parameters |
| AN-240 | SCR Power Control Fundamentals |
| AN-245A | An Integrated Core Memory Sense Amplifier |
| AN-247A | An Integrated Circuit RF-IF Amplifier |
| AN-248 | The MC1533 Monolithic Operational Amplifier |
| AN-249 | Designing Around the Tuning Diode Inductance |
| AN-261A | Transistor Logarithmic Conversion Using An Operational Amplifier |
| AN-267 | Matching Network Designs with Computer Solutions |
| AN-268 | Pulse Triggering of Radar Modulator SCR's |
| AN-270 | Nanosecond Pulse Handling Techniques In IC Interconnections |
| AN-273A | More Value Out of Integrated Operational Amplifier Data Sheets |
| AN-282A | Systemizing RF Power Amplifier Design |
| AN-290B | Mounting Procedure for, and Thermal Aspects of, Thermopad Plastic Power Devices |
| AN-293 | Theory and Characteristics of the Unijunction Transistor |
| AN-294 | Unijunction Transistor Timers and Oscillators |
| AN-295 | Suppressing RFI in Thyristor Circuits |

APPLICATION NOTE NUMBER TITLE

| | |
|---------|--|
| AN-298 | Noise Immunity With High Threshold Logic |
| AN-299 | An IC Wideband Video Amplifier With AGC |
| AN-401 | The MC1554 One-Watt Monolithic Integrated Circuit Power Amplifier |
| AN-403 | Single Power Supply Operation of IC Op Amps |
| AN-404 | A Wideband Monolithic Video Amplifier |
| AN-407 | A General Purpose IC Differential Output Operational Amplifier |
| AN-411 | The MC1535 Monolithic Dual Op-Amp |
| AN-413 | Unijunction Trigger Circuits for Gated Thyristors |
| AN-414 | Operation and Application of MHTL IC Flip-Flops |
| AN-415A | Avoiding Second Breakdown |
| AN-416 | One-Step High Order Frequency Multipliers |
| AN-417A | IC Crystal Controlled Oscillators |
| AN-418 | High Speed Monostable Multivibrator Design With MECL Integrated Circuits |
| AN-419 | UHF Amplifier Design Using Data Sheet Design Curves |
| AN-421 | Semiconductor Noise Figure Considerations |
| AN-423 | Field-Effect Transistor RF Amplifier Design Techniques |
| AN-426A | Low-Power Audio Amplifiers Using Complementary Plastic Transistors |
| AN-436 | Conventional and Self-Start Dimming of Incandescent Lights |
| AN-437B | Design Considerations and Performance of Motorola Temperature-Compensated Zener Reference Diodes |
| AN-439 | MC1539 Op-Amp and its Applications |
| AN-440 | Theory and Characteristics of Phototransistors |
| AN-442 | Designing DC-DC Converters for Capacitor Charging With Batteries |
| AN-443 | Directional and Speed Control for Series, Universal and Shunt Motors |
| AN-445 | Pulse-Width Modulation for DC-Motor Speed Control |
| AN-447 | Fast Charging Systems for Ni-Cd Batteries |
| AN-455 | Using the FET Designer Data Sheet for Worst Case Amplifier Circuit Design |

APPLICATION NOTE
NUMBER TITLE

| | |
|---------|---|
| AN-459 | A Simple Technique for Extending Op-Amp Power Bandwidth |
| AN-460 | Using Transient Response to Determine Operational Amplifier Stability |
| AN-461 | Transient Suppression With a Power Zener Diode |
| AN-462 | FET Current Regulators — Circuits and Diodes |
| AN-464 | MTTL Designer's Note — The MC4004/MC4005, A 16-Bit Random Access Memory |
| AN-465 | MTTL Designer's Note — The MC4006/MC4007 Decoders |
| AN-466 | Circuit Applications for the Triac |
| AN-467 | Using Motorola High Threshold Logic |
| AN-469 | Line Operated 15-kHz Inverter |
| AN-470 | Bipolar Chopper Transistors and Circuits |
| AN-471 | Analog-to-Digital Conversion Techniques |
| AN-472 | Mounting and Heat Sinking UniWatt Plastic Transistors |
| AN-473 | A Monolithic High-Power Series Voltage Regulator |
| AN-474 | The MC1541 — A Gated Dual-Channel Sense Amplifier for Core Memories |
| AN-475 | Using the MC1545 — A Monolithic, Gated-Video Amplifier |
| AN-478A | Small-Signal RF Design With Dual-Gate MOSFETs |
| AN-481 | A Broadband 4-Watt Aircraft Transmitter |
| AN-482 | Electronic Speed Control of Appliance Motors |
| AN-483B | 20 and 30 Watt Power Amplifiers Using Darlington Output Transistors |
| AN-484A | Medium-Power Audio Amplifiers |
| AN-485 | High-Power Audio Amplifiers With Short-Circuit Protection |
| AN-488 | High-Speed Addition Using Lookahead Carry Techniques |
| AN-489 | Analysis and Basic Operation of the MC1595 |
| AN-491 | Gated Video Amplifier Applications, the MC1545 |
| AN-493 | The MC3000/MC3100 Series Transistor-Transistor Logic Flip-Flops |
| AN-496A | Error Detection and Correction Using Exclusive-OR Gates and Parity Trees |
| AN-498 | Voltage and Current Boost Techniques Using the MC1560-61 |
| AN-499 | Shutdown Techniques for the MC1560-61/69 Monolithic Voltage Regulators |
| AN-500 | Development, Analysis, and Basic Operation of the MC1560-61 Monolithic Voltage Regulators |
| AN-504 | The MC1600 Series MECL III Gates |
| AN-505 | The MC4012, A MTTL 4-Bit Shift Register |
| AN-506 | Code Conversion With Semiconductor Read Only Memories |
| AN-507 | A 13-Watt Broadband AM Aircraft Transmitter |
| AN-508 | Applications of Phototransistors in Electro-Optic Systems |
| AN-509 | True RMS Voltage Regulators |
| AN-511 | Low Frequency Applications of Field-Effect Transistors |
| AN-512 | Applications of Fast-Recovery Rectifiers |
| AN-513 | A High Gain Integrated Circuit RF-IF Amplifier With Wide Range AGC |

APPLICATION NOTE
NUMBER TITLE

| | |
|---------|---|
| AN-517 | Improving the Efficiency of Low-Voltage, High-Current Rectification |
| AN-518 | Constant-Speed Motor Control Using Tachometer Feedback |
| AN-519 | Using MDTL Logic Blocks |
| AN-521 | Using Balanced Emitter Transistors in RF Applications |
| AN-522 | The MC1556 Operational Amplifier and its Applications |
| AN-524 | Converting Relay Control Systems to Digital ICs |
| AN-526 | Theory, Characteristics and Applications of Silicon Unilateral and Bilateral Switches |
| AN-527 | Theory, Characteristics and Applications of the Programmable Unijunction Transistor |
| AN-529 | Regulated Line Operated Inverter Uses High Voltage Power Transistors and Hot-Carrier Rectifiers |
| AN-530A | The MC7491A Eight-Bit Serial Shift Register and the MC7495 Four-Bit Shift Register |
| AN-531 | MC1596 Balanced Modulator |
| AN-532A | MTTL and MECL Avionics Digital Frequency Synthesizers |
| AN-533 | Semiconductors for Plated-Wire Memories |
| AN-535 | Phase-Locked Loop Design Fundamentals |
| AN-536 | Micro-T Packaged Transistors for High-Speed Logic Systems |
| AN-540 | A Synchronously Gated N-Decade Sweep Oscillator |
| AN-541 | Medium Scale Integration in the Numerical Control Field |
| AN-543 | Integrated Circuit IF Amplifiers for AM/FM and FM Radios |
| AN-544A | Printed Circuit VHF TV Tuners Using Tuning Diodes |
| AN-545 | Television Video IF Amplifier Using Integrated Circuits |
| AN-546 | Solid-State Linear Power Amplifier Design |
| AN-547 | A High-Speed Dual Differential Comparator, the MC1511 |
| AN-548A | Microstrip Design Techniques for UHF Amplifiers |
| AN-549 | A Vertical Deflection Circuit Using Complementary Transistors |
| AN-550 | Programming the MCM5003/5004 Programmable Read Only Memory |
| AN-551 | Tuning Diode Design Techniques |
| AN-552 | The Control Engineer's Guide to IC Applications |
| AN-553 | A New Generation of Integrated Avionic Synthesizers |
| AN-555 | Mounting Stripline-Opposed-Emitter (SDE) Transistors |
| AN-556 | Interconnection Techniques for Motorola's MECL 10,000 Series Emitter Coupled Logic |
| AN-557 | Analog-to-Digital Cyclic Converter |
| AN-559 | Simple RAMP A/D Converter |
| AN-560 | Designing Tuned Lines for UHF TV Tuners |
| AN-561 | How to Use Photosensors and Light Sources |
| AN-563 | Hybrid Gain Modules for Use in CATV Trunk and Line Extender Amplifiers |
| AN-564 | An AOF Frequency Synthesizer Utilizing Phase-Locked Looped Integrated Circuits |
| AN-565 | Using Shift Registers as Pulse Delay Networks |
| AN-566 | High-Speed Binary Multiplication Using the MC10181 |
| AN-567 | MECL Positive and Negative Logic |
| AN-568 | A Fuse-Thyristor Coordination Primer |

APPLICATION NOTE
NUMBER TITLE

| | |
|---------|--|
| AN-569 | Transient Thermal Resistance — General Data and Its Use |
| AN-571 | Isolation Techniques Using Optical Couplers |
| AN-574 | CMOS: A New Logic Type for Control Systems |
| AN-575A | Variable Speed Control System for Induction Motors |
| AN-576 | The Logical Design of Shift Counters |
| AN-577 | Design Techniques for an 80-Watt, 175 MHz Transmitter for 12.5 Volt Operation |
| AN-578 | UHF Microstrip Amplifiers Utilizing G-10 Epoxy-Glass Laminate |
| AN-579 | Testing MECL 10,000 Integrated Logic Circuits |
| AN-580 | Thermal Runaway in High Power Thyristors |
| AN-581 | An MSI 1500-MHz Frequency Counter Using MECL and MTTL |
| AN-583 | A MECL 10,000 Main-Frame Memory System Employing Dynamic MOS RAMs |
| AN-584 | Programmable Counters Using the MC10136 and MC10137 MECL 10,000 Universal Counters |
| AN-585 | VHF Power Amplifiers Using Paralleled Output Transistors |
| AN-586 | Measuring Frequency and Propagation Delay With High-Speed MECL Circuits |
| AN-587 | Analysis and Design of the Op-Amp Current Source |
| AN-588 | A 20 kHz, 1 kW Line Operated Inverter |
| AN-589 | Generate Custom Waveforms Digitally |
| AN-590 | Servo Motor Drive Amplifiers |
| AN-592 | AC Noise Immunity of MECL 10,000 Integrated Circuits |
| AN-593 | Broadband Linear Power Amplifiers Using Push-Pull Transistors |
| AN-594 | A Frequency Synthesizer for Aircraft Automatic Direction Finding Systems |
| AN-595 | 25-Watt and 10-Watt VHF Marine Band Transmitters |
| AN-596 | A Class D Citizen's Band Transmitter Using Low-Cost Plastic Transistors |
| AN-597 | Power Control Using the Zero Voltage Switch |
| AN-598A | Four Terminal, Optically Isolated Zero Crossing AC Relay |
| AN-599 | Mounting Techniques for Metal Packaged Power Semiconductors |
| AN-700 | Simulate MECL System Interconnections With A Computer Program |
| AN-701 | Understanding MECL 10,000 DC and AC Data Sheet Specifications |
| AN-702 | High-Speed Digital-To-Analog and Analog-To-Digital Techniques |
| AN-703 | Designing Digitally-Controlled Power Supplies |
| AN-704 | Broadband Network Design for UHF Amplifiers |
| AN-705 | Pulse Width Modulation for Small DC Motor Control |
| AN-706 | A CRT Display System Using NMOS Memories |
| AN-707 | Noise Immunity Comparison of CMOS Versus Popular Bipolar Logic Families |
| AN-708 | Line Driver and Receiver Considerations |
| AN-709 | MECL 10,000 Arithmetic Elements MC10179, MC10180, MC10181 |

APPLICATION NOTE
NUMBER TITLE

| | |
|-------------------|---|
| AN-710 | Communication System Transmission Losses |
| AN-711 | The Recovery of Recorded Digital Information in Drum, Disk and Tape Systems |
| AN-712A | Interface Techniques Between Industrial Logic and Power Devices |
| AN-713 | Binary D/S Converters can Provide BCD-Coded Conversion |
| AN-714 | A Personalized Heart-Rate Monitor With Digital Readout |
| AN-715 | Introduction to CMOS IC's With 3-State Outputs |
| AN-716 | Successive Approximation A/D Conversion |
| AN-717 | Battery Powered 5-MHz Frequency Counter |
| AN-718A | Industrial Clock/Timer Featuring Back-Up Power Supply Operation |
| AN-719 | A New Approach to Switching Regulators |
| AN-720 | Interfacing With MECL 10,000 |
| AN-721 | Impedance Matching Networks Applied to RF Power Transistors |
| AN-312 (European) | |
| AN-722 | Replacing Sequential Logic With ROMs |
| AN-724 | Operational Aspects of Motorola's Data Terminal |
| AN-725 | A Low-Cost 80 V-1.5 A Color TV Power Supply |
| AN-726 | Bussing With MECL 10,000 Integrated Circuits |
| AN-727 | Television Horizontal APC/AFC Loops: The Last 10 Percent |
| AN-728 | 13-Watt Microstrip Amplifier for 220-225 MHz Operation |
| AN-729 | A Medium Cost PLL Varactor Tuning System Utilizing Off-the-Shelf Logic |
| AN-730 | A High-Speed FIFO Memory Using the MECL MC10143 Register File |
| AN-731 | Low-Speed Modem Fundamentals |
| AN-732 | A Non-Volatile Microprocessor Memory Using 4K N-Channel MOS RAMs |
| AN-733 | A ROM-Digital Approach to PWM-Type Speed Control of ac Motors |
| AN-734 | SCR Controller for a Series Field dc Motor |
| AN-735 | Solid-State Gas/Smoke Detector System |
| AN-736 | Lead Forming Tool for Plastic Micro-T Devices |
| AN-737 | Switched Mode Power Supplies — Highlighting a 5-V, 40-A Inverter Design |
| AN-738 | N8CD Sign and Magnitude Adder/Subtractor |
| AN-739 | A Synthetic Spectrum Tuning System for TV |
| AN-740 | The Designing on N-Channel 16 x 16-8bit Memory System for the PDP-11 |
| AN-741 | Interface Considerations for Numeric Display Systems |
| AN-742 | A 200 MHz Autoranging MECL-McMOS Frequency Counter |
| AN-743 | Five-Digit Accumulator/Elapsed Time Indicator |
| AN-744 | A Phase-Locked Loop Tuning System for Television |
| AN-746 | A 3½-Digit DVM Using An Integrated Circuit Dual Ramp System |
| AN-747 | Low-Speed Modem System Design Using the MC6860 |
| AN-748 | Applications of MC1405/MC14435 in Digital Meters |
| AN-749 | Broadband Transformers and Power Combining Techniques for RF |
| AN-750 | A Self-Regulating Horizontal Scan System |

APPLICATION NOTE
NUMBER TITLE

- AN-751 A Dissociated Inter-carrier Television Video IF Amplifier
- AN-752 An 80-Watt Switching Regulator for CATV and Industrial Applications
- AN-753 Scanning Logic for RF Scanner-Receiver Using CMOS Integrated Circuits
- AN-754 Device Operation and System Implementation of the Asynchronous Communications Interface Adapter (MC6850)

APPLICATION NOTE
NUMBER TITLE

- AN-755 Solid-State Relays for AC Power Control
- *AN-756 Crystal Switching Methods for MC12060/MC12061 Oscillators
- *AN-757 Analog-to-Digital Conversion Techniques With the M6800 Microprocessor System

*Available Soon.

ENGINEERING BULLETINS SELECTION GUIDE

The Engineering Bulletins listed below have been prepared to acquaint the systems engineer with the broad line of Semiconductor Products and their applications.

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ENGINEERING BULLETIN
NUMBER TITLE

- EB-1 Sensitive Gate Triacs Form IC Alliance — Operate Loads to 4 A — 600 V
- EB-4 We Sense A Change in You, Friend . . .
- EB-5 Get the Drift, Men . . .
- EB-7 Madam! Your Circuit Scheme Shows Symptoms of Triac Inadequacy
- EB-8 How to Apply the MHW709/710 UHF Power Modules
- EB-10 Scope's Vertical Amplified by New Circuit
- EB-11 Scope Sweep is Quick on the Trigger
- EB-12 Clock/Timer Controls Time-Dependent Industrial Systems
- EB-13 Switching Regulators Head 'Em Off at the Series Pass
- EB-14 Simple Linear Voltage Sweep Uses the MC1555 Timer
- EB-15 Power Darlington Design Tips
- EB-17 Simple VHF Broadband Design Uses CD Transistor Lineup
- EB-18 CD, Modular Techniques Make 45 Watt UHF Amplifier Practical
- EB-19 Controlled-D RF Technology — What It Means, How it's Done
- EB-20 Multiplier/Dp-Amp Circuit Detects True RMS
- EB-21 DAC Key to Inexpensive 2 2/3 Digit Voltmeter
- EB-22 Economical 225 MHz Receiver Front End Employs FETs
- EB-23 How to Apply the MHW601/602 VHF Power Modules
- EB-24 Input Buffer Circuits for the MC1505 Dual Ramp A-to-D Converter Subsystem
- EB-25 Four Building Block Amplifiers for 900 MHz Communications
- EB-26 A Metallization System for UHF and Microwave Power Transistors
- EB-27 Get 300 Watts PEP Linear Across 2 to 30 MHz From This Push-Pull Amplifier
- EB-28 Low-Cost, Easy-to-Build Exciter/Multiplier for 225 MHz FM Transmitters
- EB-29 The Common Emitter TD-39 and its Advantages
- EB-30 Sensitive Gate SCRs — Don't Forget the Gate Cathode Resistor
- EB-31 Performance of the MHW560 Series of CATV Amplifier Modules in 50 Ohm Systems
- EB-32 A Complementary Symmetry Amplifier for 2 to 30 MHz SSB Driver Applications

ENGINEERING BULLETIN
NUMBER TITLE

- EB-33 Solid-State Gas/Smoke Detector Systems
- EB-34 A Low-Cost 18.75 MHz Oscillator-Buffer for FM Transmitters
- EB-35 Autopolarity Circuits for the MC1405 Dual-Slope A/D Converter System
- EB-36 4 1/2 Digit DVM System Using the MC1505 Dual-Slope Converter
- EB-37 Amplifier Gains 10 dB Over Nine Octaves
- EB-38 Measuring the Intermodulation Distortion of Linear Amplifiers
- EB-39 80-Watt CATV Switching Regulator Useful in Industrial Amplifiers
- EB-40 Three CMOS BCD-to-Seven Segment Decoders
- EB-41 The LED Circular Timepiece
- EB-42 Motorola Field-Effect Liquid Crystal Displays — A Light Look
- EB-43 A 9 1/2 Digit Gas Discharge Display System With Leading Zero Suppression
- EB-44 An Isolated, Picket-Fence Firing Circuit for High Current SCRs
- EB-46 A Single-Device, 80-Watt, 50-Ohm VHF Amplifier
- EB-47 Event Counter and Storage Latches for High Frequency High Resolution Counters
- EB-48 A Time Base and Control Logic Subsystem for High Frequencies, High Resolution Counters
- EB-49 Application Performance of the MC6860 Modem
- EB-50 Build This Simple, Battery-Powered 3 1/2 Digit DVM From Standard Parts
- EB-51 Successive Approximation BCD A/D Converter
- EB-52 Control Your Switching Regulator With the MC3380 Astable Multivibrator
- EB-53 Two VHF Highband Gain Blocks Form 20 dB, 30-Watt Amplifier Chain
- EB-54 A Simple Line Phase-Reversal Detection Circuit
- EB-55 Battery-Powered 3 1/2 Digit Multimeter
- EB-56 A Cordless, CMOS Liquid Crystal Display Clock
- EB-57 An Economical FM Transmitter Voice Processor from a Single IC
- EB-58 Analog Data Acquisition Network for Digital Processing Using the MC1405-MC14435 A/D System



CATALOG INDEX

CATALOG INDEX

A complete index of type numbers in alphanumerical order for instant device identification. Many of the devices are referred by section and page number to more comprehensive tables in this book. Device types that are not referenced are, nevertheless, manufactured and inventoried by Motorola, but are suggested principally for replacement purposes.

SEE POPULAR PRO-ELECTRONICS
DEVICES TYPES
SECTION 8

| DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE |
|--------------|------|-----------|------|---------------------|------|----------|------|--------|------|-----------------|------|
| DIDES | | 1/4M22Z5 | | DIDES | | 1N703A-4 | | 1N728 | | 1N755AJTX | |
| Zener | | 1/4M22Z10 | | Reference | | 1N703A-5 | | 1N728A | | 1N755AJTXV | |
| 1/4M2.4A2 | | 1/4M24Z | | 4M1.36FR2 | 4-82 | 1N703A-6 | | 1N729 | | 1N756 | 4-77 |
| 1/4M2.4A25 | | 1/4M24Z5 | | 4M1.36FR5 | 4-82 | 1N704 | | 1N729A | | 1N756A | |
| 1/4M2.4A210 | | 1/4M24Z10 | | 4M2.04FR2 | 4-82 | 1N704A | | 1N730 | | 1N756AJAN | |
| 1/4M2.7A2 | | 1/4M25Z | | 4M2.04FR5 | 4-82 | 1N704A-0 | | 1N730A | | 1N756AJTX | |
| 1/4M2.7A25 | | 1/4M25Z5 | | Zener | | 1N704A-1 | | 1N731 | | 1N756AJTXV | |
| 1/4M2.7A210 | | 1/4M25Z10 | | 1M110Z55 | | 1N704A-2 | | 1N731A | | 1N757 | 4-77 |
| 1/4M3.0A2 | | 1/4M27Z | | 1M110Z55 | 4-78 | 1N704A-3 | | 1N732 | | 1N757A | |
| 1/4M3.0A25 | | 1/4M27Z5 | | 1M120Z55 | | 1N704A-4 | | 1N732A | | 1N757AJAN | |
| 1/4M3.0A210 | | 1/4M27Z10 | | 1M120Z55 | 4-78 | 1N704A-5 | | 1N733 | | 1N757AJTX | |
| 1/4M3.3A2 | | 1/4M30Z | | 1M120Z510 | 4-78 | 1N705 | | 1N733A | | 1N757AJTXV | |
| 1/4M3.3A25 | | 1/4M30Z5 | | 1M130Z55 | | 1N705A | | 1N734 | | 1N758 | 4-77 |
| 1/4M3.3A210 | | 1/4M30Z10 | | 1M130Z510 | 4-78 | 1N705A-0 | | 1N734A | | 1N758A | |
| 1/4M3.6A2 | | 1/4M33Z | | 1M140Z55 | | 1N705A-1 | | 1N735 | | 1N758AJAN | |
| 1/4M3.6A25 | | 1/4M33Z5 | | 1M140Z510 | 4-78 | 1N705A-2 | | 1N735A | | 1N758AJTX | |
| 1/4M3.6A210 | | 1/4M33Z10 | | 1M150Z55 | | 1N705A-3 | | 1N736 | | 1N758AJTXV | |
| 1/4M3.9A2 | | 1/4M36Z | | 1M150Z510 | 4-78 | 1N705A-4 | | 1N736A | | 1N759 | 4-77 |
| 1/4M3.9A25 | | 1/4M36Z5 | | 1M160Z510 | 4-78 | 1N705A-5 | | 1N737 | | 1N759A | |
| 1/4M3.9A210 | | 1/4M36Z10 | | 1M175Z55 | | 1N705A-6 | | 1N737A | | 1N759AJAN | |
| 1/4M4.3A2 | | 1/4M39Z | | 1M175Z510 | 4-78 | 1N705A-7 | | 1N738 | | 1N759AJTX | |
| 1/4M4.3A25 | | 1/4M39Z5 | | 1M180Z510 | 4-78 | 1N705A-8 | | 1N738A | | 1N759AJTXV | |
| 1/4M4.3A210 | | 1/4M39Z10 | | 1M200Z55 | | 1N706 | | 1N739 | | 1N761 | |
| 1/4M4.7A2 | | 1/4M43Z | | 1M200Z510 | 4-78 | 1N706A | | 1N739A | | 1N761A | |
| 1/4M4.7A25 | | 1/4M43Z5 | | RECTIFIERS | | 1N706A-0 | | 1N740 | | 1N761-1 | |
| 1/4M4.7A210 | | 1/4M43Z10 | | 1N248B | 4-87 | 1N706A-1 | | 1N740A | | 1N761-2 | |
| 1/4M5.1A2 | | 1/4M45Z | | 1N248C | | 1N706A-2 | | 1N741 | | 1N762 | |
| 1/4M5.1A25 | | 1/4M45Z5 | | 1N249B | 4-87 | 1N706A-3 | | 1N741A | | 1N762A | |
| 1/4M5.1A210 | | 1/4M45Z10 | | 1N249C | | 1N706A-4 | | 1N742 | | 1N762-1 | |
| 1/4M5.6A2 | | 1/4M47Z | | 1N250B | 4-87 | 1N706A-5 | | 1N742A | | 1N762-2 | |
| 1/4M5.6A25 | | 1/4M47Z5 | | 1N250C | | 1N706A-6 | | 1N743 | | 1N763 | |
| 1/4M5.6A210 | | 1/4M47Z10 | | DIODES | | 1N706A-7 | | 1N743A | | 1N763A | |
| 1/4M6.2A2 | | 1/4M50Z | | TC | | 1N706A-8 | | 1N744 | | 1N763-1 | |
| 1/4M6.2A25 | | 1/4M50Z5 | | 1N429 | 4-80 | 1N706A-9 | | 1N744A | | 1N763-2 | |
| 1/4M6.2A210 | | 1/4M50Z10 | | 1N429JAN | | 1N707 | | 1N745 | | 1N763-3 | |
| 1/4M6.8A2 | | 1/4M52Z | | RECTIFIERS | | | | | | | |

CATALOG INDEX (continued)

| DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE |
|------------|------|------------|------|------------|------|------------|------|------------|------|------------|------|
| LN825JTX | 4-79 | LN962A | | LN976A | | LN990A | | LN1318 | | LN1368A,AR | |
| LN825JTXV | | LN962B | | LN976B | | LN990B | | LN1318A | | LN1369,R | |
| LN827 | 4-79 | LN962BJAN | | LN976BJAN | | LN990BJAN | | LN1319 | | LN1369A,AR | |
| LN827A | 4-79 | LN962BJLX | | LN976BJTX | | LN990BJTX | | LN1319A | | LN1370,R | |
| LN827JAN | | LN962BJLXV | | LN976BJTXV | | LN990BJTXV | | LN1320 | | LN1370A,AR | |
| LN827JTX | 4-79 | LN963 | 4-77 | LN977 | 4-77 | LN991 | | LN1320A | | LN1371,R | |
| LN827JTXV | | LN963A | 1 | LN977A | | LN991A | | LN1321 | | LN1371A,AR | |
| LN829 | 4-79 | LN963B | | LN977B | | LN991B | | LN1321A | | LN1372,R | |
| LN829A | 4-79 | LN963BJAN | | LN977BJAN | | LN991BJAN | | LN1322 | | LN1372A,AR | |
| LN829JAN | | LN963BJTX | | LN977BJTX | | LN991BJTX | | LN1322A | | LN1373,R | |
| LN829JTX | 4-79 | LN963BJTXV | | LN977BJTXV | | LN991BJTXV | | LN1323 | | LN1373A,AR | |
| LN829JTXV | | LN964 | 4-77 | LN978 | 4-77 | LN992 | | LN1323A | | LN1374,R | |
| LN935 | 4-79 | LN964A | | LN978A | | LN992A | | LN1324 | | LN1374A,AR | |
| LN935A | 4-79 | LN964B | | LN978B | | LN992B | | LN1324A | | LN1375,R | |
| LN935B | 4-79 | LN964BJAN | | LN978BJAN | | LN992BJAN | | LN1325 | | LN1375A,AR | |
| LN935BJAN | 4-79 | LN964BJTX | | LN978BJTX | | LN992BJTX | | LN1325A | | LN1507 | |
| LN935BJTX | 4-79 | LN964BJTXV | | LN978BJTXV | | LN992BJTXV | | LN1326 | | LN1507A | |
| LN935BJTXV | 4-79 | LN965 | 4-77 | LN979 | | | | LN1326A | | LN1508 | |
| LN936 | 4-79 | LN965A | | LN979A | | RECTIFIERS | | LN1327 | | LN1508A | |
| LN936A | 4-79 | LN965B | | LN979B | | LN1115,R | | LN1327A | | LN1509 | |
| LN936B | 4-79 | LN965BJAN | | LN979BJAN | | LN1116,R | | | | LN1509A | |
| LN937 | 4-79 | LN965BJTX | | LN979BJTX | | LN1117,R | | RECTIFIERS | | LN1510 | |
| LN937A | 4-79 | LN965BJTXV | | LN979BJTXV | | LN1118,R | | LN1341,R | | LN1510A | |
| LN937B | 4-79 | LN966 | 4-77 | LN980 | 4-77 | LN1119,R | | LN1341A,RA | | LN1511 | |
| LN937BJAN | 4-79 | LN966A | | LN980A | | LN1120,R | | LN1341B,RB | | LN1511A | |
| LN937BJTX | 4-79 | LN966B | | LN980B | | LN1124,R | | LN1342,R | | LN1512 | |
| LN937BJTXV | 4-79 | LN966BJAN | | LN980BJAN | | LN1124A,RA | | LN1342A,RA | | LN1512A | |
| LN938 | 4-79 | LN966BJLX | | LN980BJTX | | LN1125,R | | LN1342B,RB | | LN1513 | |
| LN938A | 4-79 | LN966BJLXV | | LN980BJTXV | | LN1125A,RA | | LN1343,R | | LN1513A | |
| LN938B | 4-79 | LN967 | 4-77 | LN981 | 4-77 | LN1126,R | | LN1343A,RA | | LN1514 | |
| LN938BJAN | 4-79 | LN967A | | LN981A | | LN1126A,RA | | LN1343B,RB | | LN1514A | |
| LN938BJTX | 4-79 | LN967B | | LN981B | | LN1127,R | | LN1344,R | | LN1515 | |
| LN938BJTXV | 4-79 | LN967BJAN | | LN981BJAN | | LN1127A,RA | | LN1344A,RA | | LN1515A | |
| LN939 | 4-79 | LN967BJTX | | LN981BJTX | | LN1128,R | | LN1344B,RB | | LN1516 | |
| LN939A | 4-79 | LN967BJTXV | | LN981BJTXV | | LN1128A,RA | | LN1345,R | | LN1516A | |
| LN939B | 4-79 | LN968 | 4-77 | LN982 | 4-77 | LN1183 | 4-87 | LN1345A,RA | | LN1517 | |
| LN939BJAN | 4-79 | LN968A | | LN982A | | LN1183A | 4-87 | LN1345B,RB | | LN1517A | |
| LN939BJTX | 4-79 | LN968B | | LN982B | | LN1184 | 4-87 | LN1346,R | | LN1518 | |
| LN939BJTXV | 4-79 | LN968BJAN | | LN982BJAN | | LN1184A | 4-87 | LN1346A,RA | | LN1518A | |
| LN940 | | LN968BJTX | | LN982BJTX | | LN1185 | | LN1346B,RB | | LN1519 | |
| LN940A | | LN968BJTXV | | LN982BJTXV | | LN1185A | | LN1347,R | | LN1519A | |
| LN941 | 4-79 | LN969 | 4-77 | LN983 | 4-77 | LN1186 | 4-87 | LN1347A,RA | | LN1520 | |
| LN941A | 4-79 | LN969A | | LN983A | | LN1186A | 4-87 | LN1347B,RB | | LN1520A | |
| LN941B | 4-79 | LN969B | | LN983B | | LN1187 | | LN1348,R | | LN1521 | |
| LN941BJAN | 4-79 | LN969BJAN | | LN983BJAN | | LN1187A | | LN1348A,RA | | LN1521A | |
| LN941BJTX | 4-79 | LN969BJLX | | LN983BJTX | | LN1188 | 4-87 | LN1348B,RA | | LN1522 | |
| LN942 | 4-79 | LN969BJLXV | | LN983BJTXV | | LN1188A | 4-87 | LN1349,RA | | LN1522A | |
| LN942A | 4-79 | LN970 | 4-77 | LN984 | 4-77 | LN1189 | | | | LN1523 | |
| LN942B | 4-79 | LN970A | | LN984A | | LN1189A | | DIODES | | LN1523A | |
| LN943 | 4-79 | LN970B | | LN984B | | LN1190 | 4-87 | Zener | | LN1524 | |
| LN943A | 4-79 | LN970BJAN | | LN984BJAN | | LN1190A | 4-87 | LN1351,R | | LN1524A | |
| LN943B | 4-79 | LN970BJTX | | LN984BJTX | | LN1191 | 4-87 | LN1352,R | | LN1525 | |
| LN943BJAN | 4-79 | LN970BJTXV | | LN984BJTXV | | LN1192 | 4-87 | LN1352A,AR | | LN1525A | |
| LN943BJTX | 4-79 | LN971 | 4-77 | LN985 | 4-77 | LN1193 | 4-87 | LN1353,R | | LN1526 | |
| LN944 | 4-79 | LN971A | | LN985A | | LN1194 | 4-87 | LN1353A,AR | | LN1526A | |
| LN944A | 4-79 | LN971B | | LN985B | | LN1195 | | LN1354,R | | LN1527 | |
| LN944B | 4-79 | LN971BJAN | | LN985BJAN | | LN1195A | | LN1354A,AR | | LN1527A | |
| LN944BJAN | 4-79 | LN971BJTX | | LN985BJTX | | LN1196 | 4-87 | LN1355,R | | LN1528 | |
| LN944BJTX | 4-79 | LN971BJTXV | | LN985BJTXV | | LN1196A | 4-87 | LN1355A,AR | | LN1528A | |
| LN945 | 4-79 | LN972 | 4-77 | LN986 | 4-77 | LN1197 | | LN1356,R | | | |
| LN945A | 4-79 | LN972A | | LN986A | | LN1197A | | LN1356A,AR | | TC | |
| LN945B | 4-79 | LN972B | | LN986B | | LN1198 | | LN1357,R | | LN1530 | 4-80 |
| LN945BJAN | 4-79 | LN972BJAN | | LN986BJAN | | LN1198A | | LN1357A,AR | | LN1530A | 4-80 |
| LN945BJTX | 4-79 | LN972BJTX | | LN986BJLX | | LN1199A | 4-87 | LN1358,R | | LN1530AJAN | |
| LN945BJTXV | 4-79 | LN972BJTXV | | LN986BJLXV | | LN1200A | 4-87 | LN1358A,AR | | | |
| | | LN973 | 4-77 | LN987 | 4-77 | LN1201A | | LN1359,R | | RECTIFIERS | |
| DIDDOS | | LN973A | | LN987A | | LN1202A | 4-87 | LN1359A,AR | | LN1537 | |
| Zener | | LN973B | | LN987B | | LN1203A | | LN1360,R | | LN1538 | |
| LN957 | 4-77 | LN973BJAN | | LN987BJAN | | LN1204A | 4-87 | LN1360A,AR | | LN1539 | |
| LN957A | | LN973BJTX | | LN987BJTX | | LN1205A | | LN1361,R | | LN1540 | |
| LN957B | | LN973BJTXV | | LN987BJTXV | | LN1206A | 4-87 | LN1361A,AR | | LN1541 | |
| LN958 | 4-77 | LN974 | 4-77 | LN988 | 4-77 | | | LN1362,R | | LN1542 | |
| LN958A | | LN974A | | LN988A | | DIODES | | LN1362A,AR | | LN1543 | |
| LN958B | | LN974B | | LN988B | | Zener | | LN1363,R | | LN1544 | |
| LN959 | 4-77 | LN974BJAN | | LN988BJAN | | LN1313 | | LN1363A,AR | | | |
| LN959A | | LN974BJTX | | LN988BJLX | | LN1313A | | LN1364,R | | DIODES | |
| LN959B | | LN974BJTXV | | LN988BJTXV | | LN1314 | | LN1364A,AR | | Zener | |
| LN960 | 4-77 | LN975 | 4-77 | LN989 | 4-77 | LN1314A | | LN1365,R | | LN1588 | |
| LN960A | | LN975A | | LN989A | | LN1315 | | LN1365A,AR | | LN1588A | |
| LN960B | | LN975B | | LN989B | | LN1315A | | LN1366,R | | LN1589 | |
| LN961 | 4-77 | LN975BJAN | | LN989BJAN | | LN1316 | | LN1366A,AR | | LN1589A | |
| LN961A | | LN975BJTX | | LN989BJTX | | LN1316A | | LN1367,R | | LN1590 | |
| LN961B | | LN975BJTXV | | LN989BJTXV | | LN1317 | | LN1367A,AR | | LN1590A | |
| LN962 | 4-77 | LN976 | 4-77 | LN990 | 4-77 | LN1317A | | LN1368,R | | LN1591 | |

CATALOG INDEX (continued)

| DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE |
|------------|------|------------|------|------------|------|------------|------|------------|------|------------|------|
| 1N1591A | | 1N1774 | | 1N1817.R | | 1N2009.R | | 1N2046A | | 1N2806B.R | |
| 1N1592 | | 1N1774A | | 1N1817A.AR | | 1N2009A.AR | | 1N2046-1 | | 1N2806BJAN | |
| 1N1592A | | 1N1775 | | 1N1817C | | 1N2009C | | 1N2046-2 | | 1N2807&R | 4-78 |
| 1N1593 | | 1N1775A | | 1N1817CA | | 1N2009CA | | 1N2046-3 | | 1N2807A.R | |
| 1N1593A | | 1N1776 | | 1N1818.R | | 1N2010.R | | 1N2047 | | 1N2807B.R | |
| 1N1594 | | 1N1776A | | 1N1818A.AR | | 1N2010A.AR | | 1N2047A | | 1N2807BJAN | |
| 1N1594A | | 1N1777 | | 1N1818C | | 1N2010C | | 1N2047-1 | | 1N2808&R | 4-78 |
| 1N1595 | | 1N1777A | | 1N1818CA | | 1N2010CA | | 1N2047-2 | | 1N2808A.R | |
| 1N1595A | | 1N1778 | | 1N1819.R | | 1N2011.R | | 1N2047-3 | | 1N2808B.R | |
| 1N1596 | | 1N1778A | | 1N1819A.AR | | 1N2011A.AR | | 1N2048 | | 1N2808BJAN | |
| 1N1596A | | 1N1779 | | 1N1819C | | 1N2011C | | 1N2048A | | 1N2809&R | 4-78 |
| 1N1597 | | 1N1779A | | 1N1819CA | | 1N2011CA | | 1N2048-1 | | 1N2809A.R | |
| 1N1597A | | 1N1780 | | 1N1820.R | | 1N2012 | | 1N2048-2 | | 1N2809B.R | |
| 1N1598 | | 1N1780A | | 1N1820A.AR | | 1N2012.R | | 1N2048-3 | | 1N2809BJAN | |
| 1N1598A | | 1N1781 | | 1N1820C | | 1N2012A.AR | | 1N2049 | | 1N2810&R | 4-78 |
| 1N1599 | | 1N1781A | | 1N1820CA | | 1N2012C | | 1N2049A | | 1N2810A.R | |
| 1N1599A | | 1N1782 | | 1N1821.R | | 1N2012CA | | 1N2049-1 | | 1N2810B.R | |
| 1N1600 | | 1N1782A | | 1N1821A.AR | | 1N2032 | | 1N2049-2 | | 1N2810BJAN | |
| 1N1600A | | 1N1783 | | 1N1821C | | 1N2032A | | 1N2049-3 | | 1N2811&R | 4-78 |
| 1N1601 | | 1N1783A | | 1N1821CA | | 1N2032-1 | | 1N2049-4 | | 1N2811A.R | |
| 1N1601A | | 1N1784 | | 1N1822.R | | 1N2032-2 | | | | 1N2811B.R | |
| 1N1602 | | 1N1784A | | 1N1822A.AR | | 1N2033 | | TC | | 1N2811BJAN | |
| 1N1602A | | 1N1785 | | 1N1822C | | 1N2033A | | 1N2163 | 4-79 | 1N2812.R | |
| 1N1603 | | 1N1785A | | 1N1822CA | | 1N2033-1 | | 1N2163A | 4-79 | 1N2812A | |
| 1N1603A | | 1N1786 | | 1N1823.R | | 1N2033-2 | | 1N2164 | 4-79 | 1N2812B.R | |
| 1N1604 | | 1N1786A | | 1N1823A.AR | | 1N2034 | | 1N2164A | 4-79 | 1N2813&R | 4-78 |
| 1N1604A | | 1N1787 | | 1N1823C | | 1N2034A | | 1N2165 | 4-79 | 1N2813A.R | |
| 1N1605 | | 1N1787A | | 1N1823CA | | 1N2034-1 | | 1N2165A | 4-79 | 1N2813B.R | |
| 1N1605A | | 1N1788 | | 1N1824.R | | 1N2034-2 | | 1N2166 | 4-79 | 1N2813BJAN | |
| 1N1606 | | 1N1788A | | 1N1824A.AR | | 1N2034-3 | | 1N2166A | 4-79 | 1N2814&R | 4-78 |
| 1N1606A | | 1N1789 | | 1N1824C | | 1N2035 | | 1N2167 | 4-79 | 1N2814A.R | |
| 1N1607 | | 1N1789A | | 1N1824CA | | 1N2035A | | 1N2167A | 4-79 | 1N2814B.R | |
| 1N1607A | | 1N1790 | | 1N1825.R | | 1N2035-1 | | 1N2168 | 4-79 | 1N2814BJAN | |
| 1N1608 | | 1N1790A | | 1N1825A.AR | | 1N2035-2 | | 1N2168A | 4-79 | 1N2815.R | |
| 1N1608A | | 1N1791 | | 1N1825C | | 1N2035-3 | | 1N2169 | 4-79 | 1N2815A.R | |
| 1N1609 | | 1N1791A | | 1N1825CA | | 1N2035-4 | | 1N2169A | 4-79 | 1N2815B.R | |
| 1N1609A | | 1N1792 | | 1N1826.R | | 1N2036 | | 1N2170 | 4-79 | 1N2816&R | 4-78 |
| RECTIFIERS | | 1N1792A | | 1N1826A.AR | | 1N2036A | | 1N2170A | 4-79 | 1N2816A.R | |
| 1N1612.R | | 1N1793 | | 1N1826C | | 1N2036-1 | | 1N2171 | 4-79 | 1N2816B | |
| 1N1613.R | | 1N1793A | | 1N1826CA | | 1N2036-2 | | 1N2171A | 4-79 | 1N2816BJAN | |
| 1N1614.R | | 1N1794 | | 1N1827.R | | 1N2037 | | DIODES | | 1N2817.R | |
| 1N1615.R | | 1N1794A | | 1N1827A.AR | | 1N2037A | | Zener | | 1N2817A.R | |
| 1N1616.R | | 1N1795 | | 1N1827C | | 1N2037-1 | | 1N2498C | | 1N2817B.R | |
| | | 1N1795A | | 1N1827CA | | 1N2037-2 | | 1N2498CA | | 1N2818&R | 4-78 |
| | | 1N1796 | | 1N1828.R | | 1N2037-3 | | 1N2498A | | 1N2818A.R | |
| DIODES | | 1N1796A | | 1N1828A.AR | | 1N2038 | | 1N2498B | | 1N2818B.R | |
| TC | | 1N1797 | | 1N1828C | | 1N2038A | | 1N2498A.AR | | 1N2818BJAN | |
| 1N1735 | | 1N1797A | | 1N1828CA | | 1N2038-1 | | 1N2499C | | 1N2819&R | 4-78 |
| 1N1736 | 4-80 | 1N1798 | | 1N1829.R | | 1N2038-2 | | 1N2499CA | | 1N2819A.R | |
| 1N1736A | 4-80 | 1N1798A | | 1N1829A.AR | | 1N2038-3 | | 1N2499B | | 1N2819B.R | |
| 1N1737 | 4-80 | 1N1799 | | 1N1829C | | 1N2039 | | 1N2499A.AR | | 1N2819BJAN | |
| 1N1737A | 4-80 | 1N1799A | | 1N1829CA | | 1N2039A | | 1N2500C | | 1N2820&R | 4-78 |
| 1N1738 | 4-80 | 1N1800 | | 1N1830.R | | 1N2039-1 | | 1N2500CA | | 1N2820A.R | |
| 1N1738A | 4-80 | 1N1800A | | 1N1830A.AR | | 1N2039-2 | | 1N2500.R | | 1N2820B.R | |
| 1N1739 | 4-80 | 1N1801 | | 1N1830C | | 1N2039-3 | | 1N2500A.AR | | 1N2820BJAN | |
| 1N1739A | 4-80 | 1N1801A | | 1N1830CA | | 1N2040 | | | | 1N2821.R | |
| 1N1740 | 4-80 | 1N1802 | | 1N1831.R | | 1N2040A | | TC | | 1N2821A.R | |
| 1N1740A | 4-80 | 1N1802A | | 1N1831A.AR | | 1N2040-1 | | 1N2620 | | 1N2821B.R | |
| 1N1741 | 4-80 | 1N1803.R | | 1N1831C | | 1N2040-2 | | 1N2620A | | 1N2822&R | 4-78 |
| 1N1741A | 4-80 | 1N1803A.AR | | 1N1831CA | | 1N2040-3 | | 1N2620B | | 1N2822A.R | |
| 1N1742 | 4-80 | 1N1806.R | | 1N1832.R | | 1N2041 | | 1N2621 | | 1N2822B.R | |
| 1N1742A | 4-80 | 1N1806A.AR | | 1N1832A.AR | | 1N2041A | | 1N2621A | | 1N2822BJAN | |
| 1N1742AJAN | | 1N1807.R | | 1N1832C | | 1N2041-1 | | 1N2621B | | 1N2823&R | 4-78 |
| | | 1N1807A.AR | | 1N1832CA | | 1N2041-2 | | 1N2622 | | 1N2823A.R | |
| DIODES | | 1N1808.R | | 1N1833.R | | 1N2042 | | 1N2622A | | 1N2823B.R | |
| Zener | | 1N1808A.AR | | 1N1833A.AR | | 1N2042A | | 1N2622B | | 1N2823BJAN | |
| 1N1765 | | 1N1809.R | | 1N1833C | | 1N2042-1 | | 1N2623 | | 1N2824&R | 4-78 |
| 1N1765A | | 1N1809A.AR | | 1N1833CA | | 1N2042-2 | | 1N2623A | | 1N2824A.R | |
| 1N1766 | | 1N1810.R | | 1N1834.R | | 1N2043 | | 1N2623B | | 1N2824B.R | |
| 1N1766A | | 1N1810A.AR | | 1N1834A.AR | | 1N2043A | | 1N2624 | | 1N2824BJAN | |
| 1N1767 | | 1N1811.R | | 1N1834C | | 1N2043-1 | | 1N2624A | | 1N2825&R | 4-78 |
| 1N1767A | | 1N1811A.AR | | 1N1834CA | | 1N2043-2 | | 1N2624B | | 1N2825A.R | |
| 1N1768 | | 1N1812.R | | 1N1835.R | | 1N2043-3 | | | | 1N2825B.R | |
| 1N1768A | | 1N1812A.AR | | 1N1835A.AR | | 1N2044 | | Zener | | 1N2825BJAN | |
| 1N1769 | | 1N1813.R | | 1N1835C | | 1N2044A | | 1N2804&R | 4-78 | 1N2826&R | 4-78 |
| 1N1769A | | 1N1813A.AR | | 1N1835CA | | 1N2044-1 | | 1N2804B.R | | 1N2826B.R | |
| 1N1770 | | 1N1814.R | | 1N1836.R | | 1N2044-2 | | 1N2804BJAN | | 1N2826BJAN | |
| 1N1770A | | 1N1814A.AR | | 1N1836A.AR | | 1N2044-3 | | 1N2805&R | 4-78 | 1N2827&R | 4-78 |
| 1N1771 | | 1N1815.R | | 1N1836C | | 1N2044-4 | | 1N2805A.R | | 1N2827A.R | |
| 1N1771A | | 1N1815A.AR | | 1N1836CA | | 1N2045 | | 1N2805B.R | | 1N2827B.R | |
| 1N1772 | | 1N1816.R | | 1N2008.R | | 1N2045A | | 1N2805BJAN | | 1N2827BJAN | |
| 1N1772A | | 1N1816A.AR | | 1N2008A.AR | | 1N2045-1 | | 1N2806&R | 4-78 | 1N2828.R | |
| 1N1773 | | 1N1816C | | 1N2008C | | 1N2045-2 | | 1N2806A.R | | | |
| 1N1773A | | 1N1816CA | | 1N2008CA | | 1N2046 | | | | | |

CATALOG INDEX (continued)

| DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE |
|------------|------|-------------|------|---------------|------|---------------|------|-------------|------|-------------|------|
| 1N2828B | | 1N2972BJAN | | 1N29918.R | 4-78 | 1N3009B.R | | 1N3025B.R | | 1N3039B.R | |
| 1N2829B.R | 4-78 | 1N2972BJX | | 1N2991A.R | | 1N3009BJAN | | 1N3025BJAN | | 1N3039BJAN | |
| 1N2829A.R | | 1N2973.R | 4-78 | 1N2991B.R | | 1N3010 | | 1N3025BJTX | | 1N3039BJTX | |
| 1N2829B.R | | 1N2973A.R | | 1N2991B.JAN.R | | 1N3010A | | 1N3025BJTXV | | 1N3039BJTXV | |
| 1N2829BJAN | | 1N2973B.R | | 1N2991BJTX.R | | 1N3010B | | 1N3026.R | 4-78 | 1N3040 | 4-78 |
| 1N2830 | | 1N2973BJAN | | 1N2992&R | 4-78 | 1N3011&R | 4-78 | 1N3026A.R | | 1N3040A.R | |
| 1N2830A | | 1N2973BJX | | 1N2992A.R | | 1N3011A.R | | 1N3026B.R | | 1N3040B.R | |
| 1N2830B | | 1N2074 | 4-78 | 1N2992B.R | | 1N3011B.R | | 1N3026BJAN | | 1N3040BJAN | |
| 1N2831&R | 4-78 | 1N2974A.R | | 1N2992BJAN | | 1N3011B.JAN.R | | 1N3026BJTX | | 1N3040BJTX | |
| 1N2831A.R | | 1N2974B.R | | 1N2992BJTX | | 1N3011BJX.R | | 1N3026BJTXV | | 1N3040BJTXV | |
| 1N2831B.R | | 1N2974BJAN | | 1N2993&R | 4-78 | 1N3012B.R | 4-78 | 1N3027 | 4-78 | 1N3041 | 4-78 |
| 1N2831BJAN | | 1N2974BJTX | | 1N2993A.R | | 1N3012A.R | | 1N3027A.R | | 1N3041A.R | |
| 1N2832&R | 4-78 | 1N2975 | 4-78 | 1N2993B.R | | 1N3012B.R | | 1N3027B.R | | 1N3041B.R | |
| 1N2832A.R | | 1N2975A.R | | 1N2993BJAN | | 1N3012BJAN | | 1N3027BJTX | | 1N3041BJAN | |
| 1N2832B.R | | 1N2975B.R | | 1N2993BJTX | | 1N3012BJTX | | 1N3027BJTXV | | 1N3041BJTX | |
| 1N2832BJAN | | 1N2975BJAN | | 1N2994 | | 1N3012BJTXV | | 1N3028 | 4-78 | 1N3041BJTXV | |
| 1N2833&R | 4-78 | 1N2975BJX | | 1N2994A.R | | 1N3013 | | 1N3028A.R | | 1N3042A.R | |
| 1N2833A.R | | 1N2976 | 4-78 | 1N2994B.R | | 1N3013A.R | | 1N3028B.R | | 1N3042B.R | |
| 1N2833B.R | | 1N2976A.R | | 1N2995 | | 1N3013B.R | | 1N3028BJAN | | 1N3042BJAN | |
| 1N2833BJAN | | 1N2976B.R | | 1N2995A.R | | 1N3014R | 4-78 | 1N3028BJTX | | 1N3042BJTX | |
| 1N2834&R | 4-78 | 1N2976B.JAN | | 1N2995B.R | | 1N3014A.R | | 1N3028BJTXV | | 1N3042BJTXV | |
| 1N2834A.R | | 1N2976BJTX | | 1N2995BJAN | | 1N3014B.R | | 1N3029 | 4-78 | 1N3043 | 4-78 |
| 1N2834B.R | | 1N2077 | 4-78 | 1N2995BJTX | | 1N3014BJAN | | 1N3029A.R | | 1N3043A.R | |
| 1N2834BJAN | | 1N2977A.R | | 1N2996&R | 4-78 | 1N3015&R | | 1N3029B.R | | 1N3043B.R | |
| 1N2835&R | 4-78 | 1N2977B.R | | 1N2996A.R | | 1N3015A.R | | 1N3029B.JAN | | 1N3043BJAN | |
| 1N2835A.R | | 1N2977BJAN | | 1N2996B.R | | 1N3015B.R | | 1N3029BJTX | | 1N3043BJTX | |
| 1N2835B.R | | 1N2977BJTX | | 1N2997&R | 4-78 | 1N3015BJAN | | 1N3029BJTXV | | 1N3043BJTXV | |
| 1N2835BJAN | | 1N2978 | | 1N2997A.R | | 1N3015BJTX | | 1N3030 | 4-78 | 1N3044 | 4-78 |
| 1N2836&R | 4-78 | 1N2978A.R | | 1N2997B.R | | 1N3016 | | 1N3030A.R | | 1N3044A.R | |
| 1N2836A.R | | 1N2978B.R | | 1N2997BJAN | | 1N3016A | | 1N3030B.R | | 1N3044B.R | |
| 1N2836B.R | | 1N2978B.JAN | 4-78 | 1N2997BJTX | | 1N3016B | | 1N3030BJAN | | 1N3044BJAN | |
| 1N2836BJAN | | 1N2979A.R | | 1N2998 | | 1N3016BJAN | | 1N3030BJTX | | 1N3044BJTX | |
| 1N2837&R | 4-78 | 1N2979B.R | | 1N2998A.R | | 1N3016BJTX | | 1N3030BJTXV | | 1N3045 | 4-78 |
| 1N2837A.R | | 1N2979BJAN | | 1N2998B.R | | 1N3016BJTXV | | 1N3031 | 4-78 | 1N3045A.R | |
| 1N2837B.R | | 1N2979BJTX | | 1N2999&R | 4-78 | 1N3017 | 4-78 | 1N3031A.R | | 1N3045B.R | |
| 1N2838BJAN | | 1N2980&R | 4-78 | 1N2999A.R | | 1N3017A.R | | 1N3031B.R | | 1N3045BJAN | |
| 1N2838&R | 4-78 | 1N2980A.R | | 1N2999B.R | | 1N3017B.R | | 1N3031BJAN | | 1N3045BJTX | |
| 1N2838A.R | | 1N2080B.R | | 1N2999BJAN | | 1N3017B.JAN | | 1N3031BJTX | | 1N3045BJTXV | |
| 1N2838B.R | | 1N2080BJAN | | 1N2000BJTX | | 1N3017BJTX | | 1N3032 | 4-78 | 1N3046 | 4-78 |
| 1N2838BJAN | | 1N2080BJTX | | 1N3000&R | 4-78 | 1N3018 | 4-78 | 1N3032A.R | | 1N3046A.R | |
| 1N2839&R | 4-78 | 1N2081A.R | | 1N3000A.R | | 1N3018A.R | | 1N3032B.R | | 1N3046B.R | |
| 1N2839A.R | | 1N2081B.R | | 1N3000B.R | | 1N3018B.R | | 1N3032BJAN | | 1N3046BJAN | |
| 1N2839B.R | | 1N2982&R | 4-78 | 1N3000BJAN | | 1N3018BJTX | | 1N3032BJTX | | 1N3046BJTX | |
| 1N2840&R | 4-78 | 1N2982A.R | | 1N3000BJTX | 4-78 | 1N3018BJTXV | | 1N3032BJTXV | | 1N3046BJTXV | |
| 1N2840A.R | | 1N2982B.R | | 1N3001&R | | 1N3019 | 4-78 | 1N3033 | 4-78 | 1N3047 | 4-78 |
| 1N2840B.R | | 1N2982B.JAN | | 1N3001A.R | | 1N3019A.R | | 1N3033A.R | | 1N3047A.R | |
| 1N2840BJAN | | 1N2082BJTX | | 1N3001B.R | | 1N3019B.R | | 1N3033B.R | | 1N3047B.R | |
| 1N2841&R | 4-78 | 1N2082BJTXV | | 1N3001BJAN | | 1N3019BJAN | | 1N3033BJAN | | 1N3047BJAN | |
| 1N2841A.R | | 1N2983.R | | 1N3001BJTX | | 1N3019BJTX | | 1N3033BJTX | | 1N3047BJTX | |
| 1N2841B.R | | 1N2083A.R | | 1N3002&R | 4-78 | 1N3019BJTXV | | 1N3033BJTXV | | 1N3047BJTXV | |
| 1N2841BJAN | | 1N2083B | | 1N3002A.R | | 1N3020 | 4-78 | 1N3034 | 4-78 | 1N3048 | 4-78 |
| 1N2842&R | 4-78 | 1N2084&R | | 1N3002B.R | | 1N3020A.R | | 1N3034A.R | | 1N3048A.R | |
| 1N2842A.R | | 1N2984A.R | | 1N3002BJAN | | 1N3020B.R | | 1N3034B.R | | 1N3048B.R | |
| 1N2842B.R | | 1N2984B.R | | 1N3002BJTX | | 1N3020BJAN | | 1N3034BJAN | | 1N3048BJAN | |
| 1N2842BJAN | | 1N2084BJAN | | 1N3003&R | 4-78 | 1N3020BJTX | | 1N3034BJTX | | 1N3048BJTX | |
| 1N2843&R | 4-78 | 1N2084BJTX | | 1N3003A.R | | 1N3020BJTXV | | 1N3034BJTXV | | 1N3048BJTXV | |
| 1N2843A.R | | 1N2985&R | 4-78 | 1N3003B.R | | 1N3021 | 4-78 | 1N3035 | 4-78 | 1N3049 | 4-78 |
| 1N2843B.R | | 1N2085A.R | | 1N3003BJAN | | 1N3021A.R | | 1N3035A.R | | 1N3049A.R | |
| 1N2843BJAN | | 1N2085B.R | | 1N3003BJTX | | 1N3021B.R | | 1N3035B.R | | 1N3049B.R | |
| 1N2844&R | 4-78 | 1N2085BJAN | | 1N3004&R | 4-78 | 1N3021BJAN | | 1N3035BJAN | | 1N3049BJAN | |
| 1N2844A.R | | 1N2085BJTX | | 1N3004A.R | | 1N3021BJTX | | 1N3035BJTX | | 1N3049BJTX | |
| 1N2844B.R | | 1N2086&R | 4-78 | 1N3004B.R | | 1N3021BJTXV | | 1N3036 | 4-78 | 1N3050 | 4-78 |
| 1N2844BJAN | | 1N2986A.R | | 1N3004BJAN | | 1N3022 | 4-78 | 1N3036A.R | | 1N3050A.R | |
| 1N2845&R | 4-78 | 1N2086B.R | | 1N3004BJTX | | 1N3022A.R | | 1N3036B.R | | 1N3050B.R | |
| 1N2845A.R | | 1N2086BJAN | | 1N3005&R | 4-78 | 1N3022B.R | | 1N3036BJAN | | 1N3050BJAN | |
| 1N2845B.R | | 1N2086BJTX | | 1N3005A.R | | 1N3022BJAN | | 1N3036BJTX | | 1N3050BJTX | |
| 1N2845BJAN | | 1N2987 | | 1N3005B.R | | 1N3022BJTX | | 1N3036BJTXV | | 1N3050BJTXV | |
| 1N2846&R | 4-78 | 1N2087A.R | | 1N3005BJAN | | 1N3022BJTXV | | 1N3037 | 4-78 | 1N3051 | 4-78 |
| 1N2846A.R | | 1N2087B.R | | 1N3005BJTX | | 1N3023 | 4-78 | 1N3037A.R | | 1N3051A.R | |
| 1N2846BJAN | | 1N2988&R | 4-78 | 1N3006 | | 1N3023A.R | | 1N3037B.R | | 1N3051B.R | |
| 1N2070&R | 4-78 | 1N2088A.R | | 1N3006A.R | | 1N3023B.R | | 1N3037BJAN | | 1N3051BJAN | |
| 1N2970A.R | | 1N2088B.R | | 1N3006B.R | | 1N3023BJAN | | 1N3037BJTX | | 1N3051BJTX | |
| 1N2970B.R | | 1N2088BJAN | | 1N3007&R | 4-78 | 1N3023BJTX | | 1N3037BJTXV | | 1N3051BJTXV | |
| 1N2970BJAN | | 1N2088BJTX | | 1N3007A.R | | 1N3023BJTXV | | 1N3038 | 4-78 | TC | |
| 1N2970BJTX | | 1N2980&R | 4-78 | 1N3007B.R | | 1N3024 | 4-78 | 1N3038A.R | | 1N3154 | 4-78 |
| 1N2971 | 4-78 | 1N2989A.R | | 1N3007BJAN | | 1N3024A.R | | 1N3038B.R | | 1N3154A.R | 4-78 |
| 1N2971A.R | | 1N2989B.R | | 1N3007BJTX | | 1N3024B.R | | 1N3038BJAN | | 1N3154BJAN | 4-78 |
| 1N2971B.R | | 1N2989BJAN | | 1N3008&R | 4-78 | 1N3024BJAN | | 1N3038BJTX | | 1N3154BJTX | 4-78 |
| 1N2971BJAN | | 1N2990&R | 4-78 | 1N3008A.R | | 1N3024BJTX | | 1N3038BJTXV | | 1N3155 | 4-78 |
| 1N2971BJTX | | 1N2990A.R | | 1N3008B.R | | 1N3024BJTXV | | 1N3039 | 4-78 | 1N3155A | 4-78 |
| 1N2972 | 4-78 | 1N2000B.R | | 1N3008BJAN | | 1N3025 | 4-78 | 1N3039A.R | | | |
| 1N2972A.R | | 1N2000BJAN | | 1N3008BJTX | | 1N3025A.R | | | | | |
| 1N2972B.R | | 1N2000BJTX | | 1N3008BJTXV | | | | | | | |

CATALOG INDEX (continued)

| DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE |
|------------|------|------------|------|------------|------|---------|------|---------|-------------|
| IN3155JAN | 4-78 | IN3320B,R | | IN3342BJAN | | IN3650 | | IN3698B | IN3807B |
| IN3155JTX | 4-78 | IN3320BJAN | | IN3343B,R | 4-78 | IN3659 | 4-87 | IN3699 | IN3808 |
| IN3156 | 4-78 | IN3321&R | 4-78 | IN3343A,R | | IN3660 | 4-87 | IN3699A | IN3808A |
| IN3155A | 4-78 | IN3321A,R | | IN3343B,R | | IN3661 | 4-87 | IN3699B | IN3808B |
| IN3156JAN | 4-78 | IN3321B,R | | IN3343BJAN | | IN3662 | | IN3700 | IN3809 |
| IN3156JTX | 4-78 | IN3321BJAN | | IN3344 | | IN3663 | 4-87 | IN3700A | IN3809A |
| IN3157 | 4-78 | IN3322&R | 4-78 | IN3344A,R | | IN3670A | | IN3700B | IN3809B |
| IN3157A | 4-78 | IN3322A,R | | IN3344B,R | | IN3671A | | IN3701 | IN3810 |
| IN3157JAN | 4-78 | IN3322B,R | | IN3344BJAN | | IN3672A | | IN3701A | IN3810A |
| IN3157JTX | 4-78 | IN3323 | | IN3345 | | IN3673A | | IN3701B | IN3810B |
| VVC | | IN3323A,R | | IN3345A,R | | | | IN3702 | IN3811 |
| IN3182 | | IN3323B,R | | IN3345B,R | | DIODES | | IN3702A | IN3811A |
| RECTIFIERS | | IN3323BJAN | | IN3346&R | 4-78 | Zener | | IN3702B | IN3811B |
| IN3208 | 4-87 | IN3324&R | 4-78 | IN3346A,R | | IN3675 | | IN3703 | IN3812 |
| IN3209 | 4-87 | IN3324A,R | | IN3346B,R | | IN3675A | | IN3703A | IN3812A |
| IN3210 | 4-87 | IN3324B,R | | IN3346BJAN | 4-78 | IN3675B | | IN3703B | IN3812B |
| IN3211 | | IN3324BJAN | | IN3347&R | 4-78 | IN3676 | | IN3704 | IN3813 |
| IN3212 | 4-87 | IN3325&R | 4-78 | IN3347A,R | | IN3676A | | IN3705 | IN3813A |
| IN3213 | | IN3325A,R | | IN3347B,R | | IN3676B | | IN3706 | IN3813B |
| IN3214 | 4-87 | IN3325B,R | | IN3347BJAN | | IN3677 | | IN3707 | IN3814 |
| DIODES | | IN3325BJAN | | IN3348 | | IN3677A | | IN3708 | IN3814A |
| Zener | | IN3326&R | 4-78 | IN3348A,R | | IN3677B | | IN3709 | IN3814B |
| IN3305 | | IN3326A,R | | IN3348B,R | | IN3678 | | IN3710 | IN3815 |
| IN3305A,R | | IN3326B,R | | IN3349&R | 4-78 | IN3678A | | IN3711 | IN3815A |
| IN3305B,R | | IN3326BJAN | 4-78 | IN3349A,R | | IN3678B | | IN3712 | IN3815B |
| IN3305BJAN | | IN3327&R | 4-78 | IN3349B,R | | IN3679 | | IN3713 | IN3816 |
| IN3306&R | 4-78 | IN3327A,R | | IN3349BJAN | | IN3679A | | IN3714 | IN3816A |
| IN3306A,R | | IN3327B,R | | IN3350&R | 4-78 | IN3679B | | IN3715 | IN3816B |
| IN3306B,R | | IN3327BJAN | | IN3350A,R | | IN3680 | | IN3716 | IN3817 |
| IN3306BJAN | | IN3328&R | 4-78 | IN3350B,R | | IN3680A | | IN3717 | IN3817A |
| IN3307&R | 4-78 | IN3328A,R | | IN3350BJAN | | IN3680B | | IN3718 | IN3817B |
| IN3307A,R | | IN3328B,R | | RECTIFIERS | | IN3681 | | IN3719 | IN3818 |
| IN3307B,R | | IN3328BJAN | | IN3491 | 4-87 | IN3681A | | IN3720 | IN3818A |
| IN3307BJAN | | IN3329 | | IN3492 | 4-87 | IN3681B | | IN3721 | IN3818B |
| IN3308&R | 4-78 | IN3329A,R | | IN3493 | 4-87 | IN3682 | | IN3722 | IN3819 |
| IN3308A,R | | IN3329B,R | | IN3494 | | IN3682A | | IN3723 | IN3819A |
| IN3308B,R | | IN3330&R | 4-78 | IN3495 | 4-87 | IN3682B | | IN3724 | IN3819B |
| IN3308BJAN | | IN3330A,R | | DIODES | | IN3683 | | IN3725 | IN3820 |
| IN3309&R | 4-78 | IN3330B,R | | TC | | IN3683A | | IN3726 | IN3820B |
| IN3309A,R | | IN3330BJAN | | IN3496 | | IN3683B | | IN3727 | IN3821 |
| IN3309B,R | | IN3331 | | IN3497 | | IN3684 | | IN3728 | IN3821A |
| IN3309BJAN | | IN3331A,R | | IN3498 | | IN3684A | | IN3729 | IN3821AJAN |
| IN3310&R | 4-78 | IN3331B,R | | IN3499 | | IN3684B | | IN3730 | IN3821AJTX |
| IN3310A,R | | IN3332&R | 4-78 | IN3500 | | IN3685 | | IN3731 | IN3821AJTXV |
| IN3310B,R | | IN3332A,R | | IN3501 | 4-81 | IN3685A | | IN3732 | IN3822 |
| IN3310BJAN | | IN3332B,R | | IN3502 | 4-81 | IN3685B | | IN3733 | IN3822A |
| IN3311&R | 4-78 | IN3332BJAN | | IN3503 | 4-81 | IN3686 | | IN3734 | IN3822AJAN |
| IN3311A,R | | IN3333 | | IN3504 | 4-81 | IN3686A | | IN3735 | IN3822AJTX |
| IN3311B,R | | IN3333A,R | | RECTIFIERS | | IN3686B | | IN3736 | IN3822AJTXV |
| IN3311BJAN | | IN3333B,R | | IN3569 | | IN3687 | | IN3737 | IN3823 |
| IN3312&R | 4-78 | IN3334&R | 4-78 | IN3570 | | IN3687A | | IN3738 | IN3823A |
| IN3312A,R | | IN3334A,R | | IN3571 | | IN3687B | | IN3739 | IN3823AJAN |
| IN3312B,R | | IN3334B,R | | IN3572 | | IN3688 | | IN3740 | IN3823AJTX |
| IN3312BJAN | | IN3334BJAN | | IN3573 | | IN3688A | | IN3741 | IN3823AJTXV |
| IN3313 | | IN3335&R | 4-78 | IN3574 | | IN3689 | | IN3742 | IN3824 |
| IN3313A,R | | IN3335A,R | | DIODES | | IN3689A | | IN3743 | IN3824A |
| IN3313B,R | | IN3335B,R | | TC | | IN3689B | | IN3744 | IN3824AJAN |
| IN3314&R | 4-78 | IN3336&R | 4-78 | IN3580 | | IN3690 | | IN3745 | IN3824AJTX |
| IN3314A,R | | IN3336A,R | | IN3580A | | IN3690A | | IN3746 | IN3824AJTXV |
| IN3314B,R | | IN3336B,R | | IN3580B | | IN3690B | | IN3747 | IN3825 |
| IN3315&R | 4-78 | IN3337&R | 4-78 | IN3581 | | IN3691 | | IN3748 | IN3825A |
| IN3315A,R | | IN3337A,R | | IN3581A | | IN3691A | | IN3749 | IN3825AJAN |
| IN3315B,R | | IN3337B,R | | IN3581B | | IN3691B | | IN3750 | IN3825AJTX |
| IN3315BJAN | | IN3338&R | 4-78 | IN3582 | | IN3692 | | IN3751 | IN3825AJTXV |
| IN3316 | | IN3338A,R | | IN3582A | | IN3692A | | IN3752 | IN3826 |
| IN3316A,R | | IN3338B,R | | IN3582B | | IN3692B | | IN3753 | IN3826A |
| IN3316B,R | | IN3338BJAN | | IN3583 | | IN3693 | | IN3754 | IN3826AJAN |
| IN3317&R | 4-78 | IN3339&R | 4-78 | IN3583A | | IN3694 | | IN3755 | IN3826AJTX |
| IN3317A,R | | IN3339A,R | | IN3583B | | IN3694A | | IN3756 | IN3826AJTXV |
| IN3317B,R | | IN3339B,R | | RECTIFIERS | | IN3694B | | IN3757 | IN3827 |
| IN3317BJAN | | IN3339BJAN | | IN3640 | | IN3695 | | IN3758 | IN3827A |
| IN3318 | | IN3340 | | IN3641 | | IN3695A | | IN3759 | IN3827AJAN |
| IN3318A,R | | IN3340A,R | | IN3642 | | IN3695B | | IN3760 | IN3827AJTX |
| IN3318B,R | | IN3340B,R | | IN3643 | | IN3696 | | IN3761 | IN3827AJTXV |
| IN3319&R | 4-78 | IN3340BJAN | | IN3644 | | IN3696A | | IN3762 | IN3828 |
| IN3319A,R | | IN3341 | | IN3645 | | IN3696B | | IN3763 | IN3828A |
| IN3319B,R | | IN3341A,R | | IN3646 | | IN3697 | | IN3764 | IN3828AJAN |
| IN3319BJAN | | IN3341B,R | | IN3647 | | IN3697A | | IN3765 | IN3828AJTX |
| IN3320&R | 4-78 | IN3342&R | 4-78 | IN3648 | | IN3697B | | IN3766 | IN3828AJTXV |
| IN3320A,R | | IN3342A,R | | IN3649 | | IN3698 | | IN3767 | IN3829 |
| | | IN3342B,R | | IN3650 | | IN3698A | | IN3768 | IN3829A |

| DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE |
|-------------------|------|--------------|------|------------|------|----------------------------|------|-------------------|------|-------------------|------|
| RECTIFIERS | | 1N4063 | 4-80 | 1N4108 | | 1N4129 | 4-77 | 1N4558R | 4-78 | 1N4580A | 4-79 |
| 1N3879 | 4-91 | 1N4063A | 4-80 | 1N4108JAN | | 1N4129JAN | | 1N4558A.R | | 1N4581 | 4-79 |
| 1N3880 | 4-91 | 1N4064 | 4-80 | 1N4108JTX | | 1N4129JTX | | 1N4558B.R | | 1N4581A | 4-79 |
| 1N3881 | 4-91 | 1N4064A | 4-80 | 1N4108JTXV | | 1N4129JTXV | | 1N4559B.R | 4-78 | 1N4582 | 4-79 |
| 1N3882 | | 1N4065 | 4-80 | 1N4109 | 4-77 | 1N4130 | 4-77 | 1N4559A.R | | 1N4582A | 4-79 |
| 1N3883 | 4-91 | 1N4065A | 4-80 | 1N4109JAN | | 1N4130JAN | | 1N4559B.R | | 1N4583 | 4-79 |
| 1N3885 | 4-91 | 1N4066 | 4-80 | 1N4109JTX | | 1N4130JTX | | 1N4560B.R | 4-78 | 1N4583A | 4-79 |
| 1N3890 | 4-91 | 1N4066A | 4-80 | 1N4109JTXV | | 1N4130JTXV | | 1N4560A.R | | 1N4584 | 4-79 |
| 1N3890JAN | 4-91 | 1N4067 | 4-80 | 1N4110 | 4-77 | 1N4131 | 4-77 | 1N4560B.R | | 1N4584A | 4-79 |
| 1N3890JTX | 4-91 | 1N4067A | 4-80 | 1N4110JAN | | 1N4131JAN | | 1N4561B.R | 4-78 | Zener | |
| 1N3890JTXV | | 1N4068 | 4-80 | 1N4110JTX | | 1N4131JTX | | 1N4561B.R | | 1N4614JAN | |
| 1N3891 | 4-91 | 1N4068A | 4-80 | 1N4110JTXV | | 1N4131JTXV | | 1N4561B.R | | 1N4614JTX | |
| 1N3891JAN | 4-91 | 1N4069 | 4-80 | 1N4111 | | 1N4132 | 4-77 | 1N4562B.R | 4-78 | 1N4614JTXV | |
| 1N3891JTX | 4-91 | 1N4069A | 4-80 | 1N4111JAN | | 1N4132JAN | | 1N4562A.R | | 1N4627JAN | |
| 1N3891JTXV | | 1N4070 | 4-80 | 1N4111JTX | | 1N4132JTX | | 1N4562B.R | | 1N4614JTX | |
| 1N3892 | | 1N4070A | 4-80 | 1N4111JTXV | | 1N4132JTXV | | 1N4563B.R | 4-78 | 1N4627JTX | |
| 1N3893 | 4-91 | 1N4071 | 4-80 | 1N4112 | 4-77 | 1N4133 | | 1N4563B.R | | 1N4614JTXV | |
| 1N3893JAN | 4-91 | 1N4071A | 4-80 | 1N4112JAN | | 1N4133JAN | | 1N4564B.R | 4-78 | 1N4627JTXV | |
| 1N3893JTX | 4-91 | 1N4072 | 4-80 | 1N4112JTX | | 1N4133JTX | | 1N4564A.R | | RECTIFIERS | |
| 1N3893JTXV | | 1N4072A | 4-80 | 1N4112JTXV | | 1N4133JTXV | | 1N4564B.R | | 1N4719 | 4-86 |
| 1N3894 | 4-91 | 1N4073 | 4-80 | 1N4113 | | 1N4134 | 4-77 | TC | | 1N4720 | 4-86 |
| 1N3895 | 4-91 | 1N4073A | 4-80 | 1N4113JAN | | 1N4134JAN | | 1N4565 | 4-79 | 1N4721 | 4-86 |
| 1N3900 | 4-91 | 1N4074 | 4-80 | 1N4113JTX | | 1N4134JTX | | 1N4565A | 4-79 | 1N4722 | 4-86 |
| 1N3901 | 4-91 | 1N4074A | 4-80 | 1N4113JTXV | | 1N4134JTXV | | 1N4565AJAN | | 1N4723 | 4-86 |
| 1N3902 | | 1N4075 | 4-80 | 1N4114 | 4-77 | 1N4135 | 4-77 | 1N4565AJTX | | 1N4724 | 4-86 |
| 1N3903 | 4-91 | 1N4075A | 4-80 | 1N4114JAN | | 1N4135JAN | | 1N4565AJTXV | | 1N4725 | 4-86 |
| 1N3909 | 4-91 | 1N4076 | 4-80 | 1N4114JTX | | 1N4135JTX | | 1N4566 | 4-79 | DIODES | |
| 1N3910 | 4-91 | 1N4076A | 4-80 | 1N4114JTXV | | 1N4135JTXV | | 1N4566A | 4-79 | Zener | |
| 1N3910JAN | 4-91 | 1N4077 | 4-80 | 1N4115 | 4-77 | 1N4370 | 4-77 | 1N4566AJAN | | 1N4728 | 4-78 |
| 1N3910JTX | 4-91 | 1N4077A | 4-80 | 1N4115JAN | | 1N4370AJAN | | 1N4566AJTX | | 1N4729A | |
| 1N3911 | 4-91 | 1N4078 | 4-80 | 1N4115JTX | | 1N4370AJTX | | 1N4566AJTXV | 4-79 | 1N4729 | 4-78 |
| 1N3911JAN | 4-91 | 1N4078A | 4-80 | 1N4115JTXV | | 1N4370AJTXV | | 1N4567AJAN | 4-79 | 1N4730A | 4-78 |
| 1N3911JTX | 4-91 | 1N4079 | 4-80 | 1N4116 | 4-77 | 1N4371 | 4-77 | 1N4567AJTX | | 1N4731 | 4-78 |
| 1N3912 | | 1N4079A | 4-80 | 1N4116JAN | | 1N4371AJAN | | 1N4567AJTXV | | 1N4731A | 4-78 |
| 1N3913 | 4-91 | 1N4080 | 4-80 | 1N4116JTX | | 1N4371AJTX | | 1N4568AJAN | 4-79 | 1N4732 | 4-78 |
| 1N3913JAN | 4-91 | 1N4080A | 4-80 | 1N4116JTXV | | 1N4371AJTXV | | 1N4568AJTX | | 1N4732A | 4-78 |
| 1N3913JTX | | 1N4081 | 4-80 | 1N4117 | | 1N4372AJAN | 4-77 | 1N4568AJTXV | 4-79 | 1N4733 | 4-78 |
| 1N3987 | | 1N4081A | 4-80 | 1N4117JAN | | 1N4372AJTX | | 1N4569 | 4-79 | 1N4733A | 4-78 |
| 1N3988 | | 1N4082 | 4-80 | 1N4117JTX | | 1N4372AJTXV | | 1N4569A | 4-79 | 1N4734 | 4-78 |
| 1N3989 | | 1N4082A | 4-80 | 1N4117JTXV | | 1N4373AJAN | | 1N4569AJAN | | 1N4735 | 4-78 |
| 1N3990 | | 1N4083 | 4-80 | 1N4118 | 4-77 | 1N4373AJTX | | 1N4569AJTX | | 1N4735A | 4-78 |
| DIODES | | 1N4083A | 4-80 | 1N4118JAN | | 1N4373AJTXV | | 1N4570 | 4-79 | 1N4736 | 4-78 |
| Zener | | 1N4084 | 4-80 | 1N4118JTX | | 1N4373AJTXV | | 1N4570A | 4-79 | 1N4736A | 4-78 |
| 1N3938R | 4-78 | 1N4084A | 4-80 | 1N4118JTXV | | Varactor Multiplier | | 1N4570AJAN | | 1N4737 | 4-78 |
| 1N3939A.R | | 1N4085 | 4-80 | 1N4119 | | 1N4386 | 4-59 | 1N4570AJTX | | 1N4737A | 4-78 |
| 1N3946R | 4-78 | 1N4085A | 4-80 | 1N4119JAN | | 1N4388 | 4-59 | 1N4570AJTXV | | 1N4738 | 4-78 |
| 1N3949A.R | | Zener | | 1N4119JTX | | Zener | | 1N4571AJAN | 4-79 | 1N4738A | 4-78 |
| 1N3955R | 4-78 | 1N4099 | 4-77 | 1N4120 | 4-77 | 1N4549R | 4-78 | 1N4571AJTX | 4-79 | 1N4739 | 4-78 |
| 1N3955A.R | | 1N4099JAN | | 1N4120JAN | | 1N4549A.R | | 1N4571AJTXV | | 1N4739A | 4-78 |
| 1N3956R | 4-78 | 1N4099JTX | | 1N4120JTX | | 1N4549B.R | | 1N4572AJAN | 4-79 | 1N4740 | 4-78 |
| 1N3956A.R | | 1N4099JTXV | 4-77 | 1N4120JTXV | | 1N4549BJAN | | 1N4572AJTX | 4-79 | 1N4741A | 4-78 |
| 1N3957R | 4-78 | 1N4100 | | 1N4121 | 4-77 | 1N4550B.R | 4-78 | 1N4572AJTXV | 4-79 | 1N4742 | 4-78 |
| 1N3957A.R | | 1N4100JAN | | 1N4121JAN | | 1N4550A.R | | 1N4573AJAN | 4-79 | 1N4743 | 4-78 |
| 1N3958R | 4-78 | 1N4100JTX | | 1N4121JTX | | 1N4550B.R | | 1N4573AJTX | 4-79 | 1N4743A | 4-78 |
| 1N3958A.R | | 1N4100JTXV | | 1N4121JTXV | 4-77 | 1N4550BJAN | | 1N4574AJAN | 4-79 | 1N4744 | 4-78 |
| 1N3959R | 4-78 | 1N4101 | 4-77 | 1N4122 | | 1N4551A.R | 4-78 | 1N4574AJTX | 4-79 | 1N4744A | 4-78 |
| 1N3959A.R | | 1N4101JAN | | 1N4122JAN | | 1N4551B.R | | 1N4574AJTXV | 4-79 | 1N4745 | 4-78 |
| 1N4000R | 4-78 | 1N4101JTX | | 1N4122JTX | | 1N4551BJAN | 4-78 | 1N4575AJAN | 4-79 | 1N4745A | 4-78 |
| 1N4000A.R | | 1N4101JTXV | | 1N4122JTXV | 4-77 | 1N4552R | | 1N4575AJTX | 4-79 | 1N4746 | 4-78 |
| RECTIFIERS | | 1N4102 | | 1N4123 | | 1N4552A.R | | 1N4575AJTXV | 4-79 | 1N4746A | 4-78 |
| 1N4001 | 4-86 | 1N4102JAN | | 1N4123JAN | | 1N4552B.R | | 1N4576AJAN | 4-79 | 1N4747 | 4-78 |
| 1N4002 | 4-86 | 1N4102JTX | | 1N4123JTX | | 1N4552BJAN | 4-78 | 1N4576AJTX | 4-79 | 1N4747A | 4-78 |
| 1N4003 | 4-86 | 1N4102JTXV | | 1N4123JTXV | | 1N4553A.R | | 1N4576AJTXV | 4-79 | 1N4748 | 4-78 |
| 1N4004 | 4-86 | 1N4103 | 4-77 | 1N4124 | 4-77 | 1N4553B.R | | 1N4577AJAN | 4-79 | 1N4748A | 4-78 |
| 1N4005 | 4-86 | 1N4103JAN | | 1N4124JAN | | 1N4553BJAN | 4-78 | 1N4577AJTX | 4-79 | 1N4749 | 4-78 |
| 1N4006 | 4-86 | 1N4103JTX | | 1N4124JTX | | 1N4554R | | 1N4577AJTXV | 4-79 | 1N4749A | 4-78 |
| 1N4007 | 4-86 | 1N4103JTXV | | 1N4124JTXV | 4-77 | 1N4554A.R | | 1N4578AJAN | 4-79 | 1N4750 | 4-78 |
| DIODES | | 1N4104 | 4-77 | 1N4125 | | 1N4554B.R | | 1N4578AJTX | 4-79 | 1N4750A | 4-78 |
| TC | | 1N4104JAN | | 1N4125JAN | | 1N4554BJAN | 4-78 | 1N4578AJTXV | 4-79 | 1N4751 | 4-78 |
| 1N4057 | 4-80 | 1N4104JTX | | 1N4125JTX | | 1N4555A.R | 4-78 | 1N4579AJAN | 4-79 | 1N4751A | 4-78 |
| 1N4057A | 4-80 | 1N4104JTXV | 4-77 | 1N4125JTXV | 4-77 | 1N4555B.R | | 1N4579AJTX | 4-79 | 1N4752 | 4-78 |
| 1N4058 | 4-80 | 1N4105 | 4-77 | 1N4126 | | 1N4556A.R | | 1N4579AJTXV | 4-79 | 1N4752A | 4-78 |
| 1N4058A | 4-80 | 1N4105JAN | | 1N4126JAN | | 1N4556B.R | 4-78 | 1N4580 | 4-79 | 1N4753 | 4-78 |
| 1N4059 | 4-80 | 1N4105JTX | | 1N4126JTX | | 1N4557R | | RECTIFIERS | | 1N4753A | 4-78 |
| 1N4059A | 4-80 | 1N4105JTXV | 4-77 | 1N4126JTXV | 4-77 | 1N4558R | | 1N4719 | 4-86 | 1N4720 | 4-86 |
| 1N4060 | 4-80 | 1N4106 | 4-77 | 1N4127 | | 1N4558A.R | | 1N4721 | 4-86 | 1N4722 | 4-86 |
| 1N4060A | 4-80 | 1N4106JAN | | 1N4127JAN | | 1N4558B.R | | 1N4723 | 4-86 | 1N4724 | 4-86 |
| 1N4061 | 4-80 | 1N4106JTX | | 1N4127JTX | | 1N4559B.R | 4-78 | 1N4725 | 4-86 | DIODES | |
| 1N4061A | 4-80 | 1N4106JTXV | 4-77 | 1N4127JTXV | 4-77 | 1N4559A.R | | Zener | | 1N4728 | 4-78 |
| 1N4062 | 4-80 | 1N4107 | | 1N4128 | | 1N4559B.R | | 1N4729A | | 1N4729 | 4-78 |
| 1N4062A | 4-80 | 1N4107JAN | | 1N4128JAN | | 1N4560B.R | 4-78 | 1N4730A | 4-78 | 1N4731 | 4-78 |
| | | 1N4107JTX | | 1N4128JTX | | 1N4560A.R | | 1N4731A | 4-78 | 1N4732 | 4-78 |
| | | 1N4107JTXV | | 1N4128JTXV | | 1N4561B.R | | 1N4732A | 4-78 | 1N4733 | 4-78 |

CATALOG INDEX (continued)

| DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE |
|---------|------|------------|------|----------------|------|---------|------|------------|------|------------|------|
| 1N4754 | 4-78 | 1N4900 | 4-79 | DIODES | | 1N5235A | | 1N5263A | | 1N5290JIX | |
| 1N4754A | | 1N4900A | 4-79 | VVC | | 1N5235B | | 1N5263B | | 1N5290JIXV | |
| 1N4755 | 4-78 | 1N4901 | 4-79 | 1N5139 | 4-66 | 1N5236 | 4-77 | 1N5264 | | 1N5291 | |
| 1N4755A | | 1N4901A | 4-79 | 1N5139A | 4-66 | 1N5236A | | 1N5264A | | 1N5291JAN | |
| 1N4756 | 4-78 | 1N4902 | 4-79 | 1N5140 | 4-66 | 1N5236B | | 1N5264B | | 1N5291JIX | |
| 1N4756A | | 1N4902A | 4-79 | 1N5140A | 4-66 | 1N5237 | 4-77 | 1N5265 | 4-77 | 1N5291JIXV | |
| 1N4757 | 4-78 | 1N4903 | 4-79 | 1N5141 | 4-66 | 1N5237A | | 1N5265A | | 1N5292 | |
| 1N4757A | | 1N4903A | 4-79 | 1N5141A | 4-66 | 1N5237B | | 1N5265B | | 1N5292JAN | |
| 1N4758 | 4-78 | 1N4904 | 4-79 | 1N5142 | 4-66 | 1N5238 | | 1N5266 | 4-77 | 1N5292JIX | |
| 1N4758A | | 1N4904A | 4-79 | 1N5142A | 4-66 | 1N5238A | | 1N5266A | | 1N5292JIXV | |
| 1N4759 | 4-78 | 1N4905 | 4-79 | 1N5143 | 4-66 | 1N5238B | | 1N5266B | | 1N5293 | |
| 1N4759A | | 1N4905A | 4-79 | 1N5143A | 4-66 | 1N5239 | 4-77 | 1N5267 | 4-77 | 1N5293JAN | |
| 1N4760 | 4-78 | 1N4906 | 4-79 | 1N5144 | 4-66 | 1N5239A | | 1N5267A | | 1N5293JIX | |
| 1N4760A | | 1N4906A | 4-79 | 1N5144A | 4-66 | 1N5239B | | 1N5267B | | 1N5293JIXV | |
| 1N4761 | 4-78 | 1N4907 | 4-79 | 1N5145 | 4-66 | 1N5240 | 4-77 | 1N5268 | 4-77 | 1N5294 | |
| 1N4761A | | 1N4907A | 4-79 | 1N5145A | 4-66 | 1N5240A | | 1N5268A | | 1N5294JAN | |
| 1N4762 | 4-78 | 1N4908 | 4-79 | 1N5146 | 4-66 | 1N5240B | | 1N5268B | | 1N5294JIX | |
| 1N4762A | | 1N4908A | 4-79 | 1N5146A | 4-66 | 1N5241 | 4-77 | 1N5269 | | 1N5294JIXV | |
| 1N4763 | 4-78 | 1N4909 | 4-79 | 1N5147 | 4-66 | 1N5241A | | 1N5269A | | 1N5295 | |
| 1N4763A | | 1N4909A | 4-79 | 1N5147A | 4-66 | 1N5241B | | 1N5269B | | 1N5295JAN | |
| 1N4764 | 4-78 | 1N4910 | 4-79 | 1N5148 | 4-66 | 1N5242 | 4-77 | 1N5270 | 4-77 | 1N5295JIX | |
| 1N4764A | | 1N4910A | 4-79 | 1N5148A | 4-66 | 1N5242A | | 1N5270A | | 1N5295JIXV | |
| | | 1N4911 | 4-79 | | | 1N5242B | | 1N5270B | | 1N5296 | |
| TC | | 1N4911A | 4-79 | Varactor | | 1N5243 | 4-77 | 1N5271 | 4-77 | 1N5296JAN | |
| 1N4765 | | 1N4912 | 4-79 | Multiplier | | 1N5243A | | 1N5271A | | 1N5296JIX | |
| 1N4765A | | 1N4912A | 4-79 | 1N5149 | 4-59 | 1N5243B | | 1N5271B | | 1N5296JIXV | |
| 1N4766 | | 1N4913 | 4-79 | 1N5150 | 4-59 | 1N5244 | | 1N5272 | 4-77 | 1N5297 | |
| 1N4766A | | 1N4913A | 4-79 | 1N5150A | 4-59 | 1N5244A | | 1N5272A | | 1N5297JAN | |
| 1N4767 | | 1N4914 | 4-79 | 1N5151 | 4-59 | 1N5244B | | 1N5272B | | 1N5297JIX | |
| 1N4767A | | 1N4914A | 4-79 | 1N5153 | 4-59 | 1N5245 | 4-77 | 1N5273 | 4-77 | 1N5297JIXV | |
| 1N4768 | | 1N4915 | 4-79 | 1N5153A | 4-59 | 1N5245A | | 1N5273A | | 1N5298 | |
| 1N4768A | | 1N4915A | 4-79 | 1N5155 | 4-59 | 1N5245B | | 1N5273B | | 1N5298JAN | |
| 1N4769 | | 1N4916 | 4-79 | 1N5155A | 4-59 | 1N5246 | 4-77 | 1N5274 | 4-77 | 1N5298JIX | |
| 1N4769A | | 1N4916A | 4-79 | THYRISTORS | | 1N5246A | | 1N5274A | | 1N5298JIXV | |
| 1N4770 | | 1N4917 | 4-79 | 4-Layer Diodes | | 1N5246B | | 1N5274B | | 1N5299 | |
| 1N4770A | | 1N4917A | 4-79 | 1N5158 | | 1N5247 | | 1N5275 | 4-77 | 1N5299JAN | |
| 1N4771 | | 1N4918 | 4-79 | 1N5159 | | 1N5247A | | 1N5275A | | 1N5299JIX | |
| 1N4771A | | 1N4918A | 4-79 | 1N5160 | | 1N5247B | | 1N5275B | | 1N5299JIXV | |
| 1N4772 | | 1N4919 | 4-79 | | | 1N5248 | 4-77 | 1N5276 | 4-77 | 1N5300 | |
| 1N4772A | | 1N4919A | 4-79 | DIDDES | | 1N5248A | | 1N5276A | | 1N5300JAN | |
| 1N4773 | | 1N4920 | 4-79 | Zener | | 1N5248B | | 1N5276B | | 1N5300JIX | |
| 1N4773A | | 1N4920A | 4-79 | 1N5221 | 4-77 | 1N5249 | | 1N5277 | 4-77 | 1N5300JIXV | |
| 1N4774 | | 1N4921 | 4-79 | 1N5221A | | 1N5249A | | 1N5277A | | 1N5301 | |
| 1N4774A | | 1N4921A | 4-79 | 1N5221B | | 1N5249B | | 1N5277B | | 1N5301JAN | |
| 1N4775 | 4-79 | 1N4922 | 4-79 | 1N5222 | | 1N5250 | 4-77 | 1N5278 | 4-77 | 1N5301JIX | |
| 1N4775A | | 1N4922A | 4-79 | 1N5222A | | 1N5250A | | 1N5278A | | 1N5301JIXV | |
| 1N4776 | 4-79 | 1N4923 | 4-79 | 1N5222B | | 1N5250B | | 1N5278B | | 1N5302 | |
| 1N4776A | | 1N4923A | 4-79 | 1N5223 | 4-77 | 1N5251 | 4-77 | 1N5279 | 4-77 | 1N5302JAN | |
| 1N4777 | 4-79 | 1N4924 | 4-79 | 1N5223A | | 1N5251A | | 1N5279A | | 1N5302JIX | |
| 1N4777A | | 1N4924A | 4-79 | 1N5223B | | 1N5251B | | 1N5279B | | 1N5302JIXV | |
| 1N4778 | 4-79 | 1N4925 | 4-79 | 1N5224 | | 1N5252 | 4-77 | 1N5280 | | 1N5303 | |
| 1N4778A | | 1N4925A | 4-79 | 1N5224A | | 1N5252A | | 1N5280A | | 1N5303JAN | |
| 1N4779 | 4-79 | 1N4926 | 4-79 | 1N5224B | | 1N5252B | | 1N5280B | | 1N5303JIX | |
| 1N4779A | | 1N4926A | 4-79 | 1N5225 | 4-77 | 1N5253 | | 1N5281 | 4-77 | 1N5303JIXV | |
| 1N4780 | 4-79 | 1N4927 | 4-79 | 1N5225A | | 1N5253A | | 1N5281A | | 1N5304 | |
| 1N4780A | | 1N4927A | 4-79 | 1N5225B | | 1N5253B | | 1N5281B | | 1N5304JAN | |
| 1N4781 | 4-79 | 1N4928 | 4-79 | 1N5226 | 4-77 | 1N5254 | 4-77 | | | 1N5304JIX | |
| 1N4781A | | 1N4928A | 4-79 | 1N5226A | | 1N5254A | | | | 1N5304JIXV | |
| 1N4782 | 4-79 | 1N4929 | 4-79 | 1N5226B | | 1N5254B | | Current | | 1N5305 | |
| 1N4782A | | 1N4929A | 4-79 | 1N5227 | 4-77 | 1N5255 | | Regulator | | 1N5305JAN | |
| 1N4783 | 4-79 | 1N4930 | 4-79 | 1N5227A | | 1N5255A | | 1N5283 | | 1N5305JIX | |
| 1N4783A | | 1N4930A | 4-79 | 1N5227B | | 1N5255B | | 1N5284 | | 1N5305JIXV | |
| 1N4784 | 4-79 | 1N4931 | 4-79 | 1N5228 | 4-77 | 1N5256 | 4-77 | 1N5285 | | 1N5306 | |
| 1N4784A | | 1N4931A | 4-79 | 1N5228A | | 1N5256A | | 1N5285A | | 1N5306JAN | |
| 1N4890 | 4-81 | 1N4932 | 4-79 | 1N5228B | | 1N5256B | | 1N5285JIX | | 1N5306JIX | |
| 1N4890A | | 1N4932A | 4-79 | 1N5229 | 4-77 | 1N5257 | 4-77 | 1N5285JIXV | | 1N5306JIXV | |
| 1N4891 | 4-81 | | | 1N5229A | | 1N5257A | | 1N5286 | | 1N5307 | |
| 1N4891A | | RECTIFIERS | | 1N5229B | | 1N5257B | | 1N5286A | | 1N5307JAN | |
| 1N4892 | 4-81 | 1N4933 | 4-91 | 1N5230 | 4-77 | 1N5258 | 4-77 | 1N5286JIX | | 1N5307JIX | |
| 1N4892A | | 1N4934 | 4-91 | 1N5230A | | 1N5258A | | 1N5286JIXV | | 1N5307JIXV | |
| 1N4893 | 4-81 | 1N4935 | 4-91 | 1N5230B | | 1N5258B | | 1N5287 | | 1N5308 | |
| 1N4893A | | 1N4936 | 4-91 | 1N5231 | 4-77 | 1N5259 | 4-77 | 1N5287A | | 1N5308JAN | |
| 1N4894 | 4-81 | 1N4937 | 4-91 | 1N5231A | | 1N5259A | | 1N5287JIX | | 1N5308JIX | |
| 1N4894A | | 1N4938 | 4-86 | 1N5231B | | 1N5259B | | 1N5287JIXV | | 1N5308JIXV | |
| 1N4895 | 4-81 | 1N4939 | 4-86 | 1N5232 | 4-77 | 1N5260 | 4-77 | 1N5288 | | 1N5309 | |
| 1N4895A | | 1N4940 | 4-86 | 1N5232A | | 1N5260A | | 1N5288A | | 1N5309JAN | |
| 1N4896 | 4-79 | 1N5000 | 4-86 | 1N5232B | | 1N5260B | | 1N5288JIX | | 1N5309JIX | |
| 1N4896A | | 1N5001 | 4-86 | 1N5233 | | 1N5261 | 4-77 | 1N5288JIXV | | 1N5309JIXV | |
| 1N4897 | 4-79 | 1N5002 | 4-86 | 1N5233A | | 1N5261A | | 1N5289 | | 1N5310 | |
| 1N4897A | | 1N5003 | 4-86 | 1N5233B | | 1N5261B | | 1N5289A | | 1N5310JAN | |
| 1N4898 | 4-79 | | | 1N5234 | 4-77 | 1N5262 | 4-77 | 1N5289JIX | | 1N5310JIX | |
| 1N4898A | | | | 1N5234A | | 1N5262A | | 1N5289JIXV | | 1N5310JIXV | |
| 1N4899 | 4-79 | | | 1N5234B | | 1N5262B | | 1N5290 | | 1N5311 | |
| 1N4899A | | | | 1N5235 | 4-77 | 1N5263 | 4-77 | 1N5290JAN | | 1N5311JAN | |

CATALOG INDEX (continued)

| DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE |
|--------------|------|---------|------|------------------|------|-----------------------|------|------------------------|-------|---------|------|
| 1N5311JTX | | 1N53558 | | 1N5383B | | 1N5533A | | 1N5820 | | 1N5926 | |
| 1N5311JTXV | | 1N5356 | | 1N5384 | 4-78 | 1N5533B | | 1N5821 | | 1N5926A | |
| 1N5312 | | 1N5356A | | 1N5384A | | 1N5534 | | 1N5823 | | 1N5926B | |
| 1N5312JAN | | 1N5356B | | 1N5384B | | 1N5534A | | 1N5824 | | 1N5927 | |
| 1N5312JTX | | 1N5357 | 4-78 | 1N5385 | | 1N5534B | | 1N5825 | | 1N5927A | |
| 1N5312JTXV | | 1N5357A | | 1N5385A | | 1N5535 | 4-77 | 1N5826 | | 1N5927B | |
| 1N5313 | | 1N5357B | | 1N5385B | | 1N5535A | | 1N5827 | | 1N5928 | |
| 1N5313JAN | | 1N5358 | 4-78 | 1N5386 | 4-78 | 1N5535B | | 1N5828 | | 1N5928A | |
| 1N5313JTX | | 1N5358A | | 1N5386A | | 1N5536 | 4-77 | 1N5829 | | 1N5928B | |
| 1N5313JTXV | | 1N5358B | | 1N5386B | | 1N5536A | | 1N5830 | | 1N5929 | |
| 1N5314 | | 1N5359 | 4-78 | 1N5387 | | 1N5536B | | 1N5831 | | 1N5929A | |
| 1N5314JAN | | 1N5359A | | 1N5387A | | 1N5537 | | 1N5832 | | 1N5929B | |
| 1N5314JTX | | 1N5359B | | 1N5387B | | 1N5537A | | 1N5833 | | 1N5930 | |
| 1N5314JTXV | | 1N5360 | | 1N5388 | 4-78 | 1N5537B | | 1N5834 | | 1N5930A | |
| | | 1N5360A | | 1N5388A | | 1N5538 | 4-77 | | | 1N5930B | |
| | | 1N5360B | | 1N5388B | | 1N5538A | | DIODES | | 1N5931 | |
| Zener | | 1N5361 | 4-78 | | | 1N5538B | | Zener | | 1N5931A | |
| 1N5333 | 4-78 | 1N5361A | | VVC | | 1N5539 | | 1N5837A | 4-77 | 1N5931B | |
| 1N5333A | | 1N5361B | | 1N5441A | 4-67 | 1N5539A | | thru | | 1N5932 | |
| 1N5333B | | 1N5362 | | thru | | 1N5539B | | 1N5873A | 4-77 | 1N5932A | |
| 1N5334 | 4-78 | 1N5362A | | 1N5456A | 4-67 | 1N5540 | 4-77 | 1N5837B | | 1N5932B | |
| 1N5334A | | 1N5362B | | 1N5441B | | 1N5540A | | thru | | 1N5933 | |
| 1N5334B | | 1N5363 | 4-78 | thru | | 1N5540B | | 1N5873B | | 1N5933A | |
| 1N5335 | 4-78 | 1N5363A | | 1N5456B | | 1N5541 | 4-77 | 1N5874A | 4-77 | 1N5933B | |
| 1N5335A | | 1N5363B | | 1N5441C | | 1N5541A | | thru | | 1N5934 | |
| 1N5335B | | 1N5364 | 4-78 | thru | | 1N5541B | | 1N5886A | 4-77 | 1N5934A | |
| 1N5336 | 4-78 | 1N5364A | | 1N5456C | | 1N5542 | 4-77 | 1N5874B | | 1N5934B | |
| 1N5336A | | 1N5364B | | 1N5461A | 4-66 | 1N5542A | | thru | | 1N5935 | |
| 1N5336B | | 1N5365 | 4-78 | thru | | 1N5542B | | 1N5886B | | 1N5935A | |
| 1N5337 | 4-78 | 1N5365A | | 1N5476A | 4-66 | 1N5543 | | 1N5887A | 4-77 | 1N5935B | |
| 1N5337A | | 1N5365B | | 1N5461B | | 1N5543A | | thru | | 1N5936 | |
| 1N5337B | | 1N5366 | 4-78 | thru | | 1N5543B | | 1N5897A | 4-77 | 1N5936A | |
| 1N5338 | 4-78 | 1N5366A | | 1N5476B | | 1N5544 | 4-77 | 1N5887B | | 1N5936B | |
| 1N5338A | | 1N5366B | | 1N5461C | | 1N5544A | | thru | | 1N5937 | |
| 1N5338B | | 1N5367 | 4-78 | thru | | 1N5544B | | 1N5897B | | 1N5937A | |
| 1N5339 | 4-78 | 1N5367A | | 1N5476C | | 1N5545 | 4-77 | | | 1N5937B | |
| 1N5339A | | 1N5367B | | | | 1N5545A | | OPTOELECTRONICS | | 1N5938 | |
| 1N5339B | | 1N5368 | 4-78 | Avalanche | | 1N5545B | | LEO | | 1N5938A | |
| 1N5340 | | 1N5368A | | 1N5518 | 4-77 | 1N5546 | | 1N5909 | 4-110 | 1N5938B | |
| 1N5340A | | 1N5368B | | 1N5518A | | 1N5546A | | 1N5910 | 4-110 | 1N5939 | |
| 1N5340B | | 1N5369 | 4-78 | 1N5518B | | 1N5546B | | 1N5911 | 4-110 | 1N5939A | |
| 1N5341 | 4-78 | 1N5369A | | 1N5519 | 4-77 | | | 1N5912 | 4-110 | 1N5939B | |
| 1N5341A | | 1N5369B | | 1N5519A | | TRANSISTORS | | | | 1N5940 | |
| 1N5341B | | 1N5370 | 4-78 | 1N5519B | | Photo | | DIODES | | 1N5940A | |
| 1N5342 | 4-78 | 1N5370A | | 1N5520 | 4-77 | 1N5722 | | Ones | | 1N5940B | |
| 1N5342A | | 1N5370B | | 1N5520A | | 1N5723 | | 1N5913 | | 1N5941 | |
| 1N5342B | | 1N5371 | | 1N5520B | | 1N5724 | | 1N5913A | | 1N5941A | |
| 1N5343 | 4-78 | 1N5371A | | 1N5521 | 4-77 | 1N5725 | | 1N5913B | | 1N5941B | |
| 1N5343A | | 1N5371B | | 1N5521A | | | | 1N5914 | | 1N5942 | |
| 1N5343B | | 1N5372 | 4-78 | 1N5521B | | THYRISTORS | | 1N5914A | | 1N5942A | |
| 1N5344 | 4-78 | 1N5372A | | 1N5522 | 4-77 | Bilateral | | 1N5914B | | 1N5942B | |
| 1N5344A | | 1N5372B | | 1N5522A | | Triggers | | 1N5915 | | 1N5943 | |
| 1N5344B | | 1N5373 | 4-78 | 1N5522B | | 1N5758 | | 1N5915A | | 1N5943A | |
| 1N5345 | | 1N5373A | | 1N5523 | 4-77 | 1N5758A | | 1N5915B | | 1N5943B | |
| 1N5345A | | 1N5373B | | 1N5523A | | 1N5759 | | 1N5916 | | 1N5944 | |
| 1N5345B | | 1N5374 | 4-78 | 1N5523B | | 1N5759A | | 1N5916A | | 1N5944A | |
| 1N5346 | 4-78 | 1N5374A | | 1N5524 | 4-77 | 1N5760 | | 1N5916B | | 1N5944B | |
| 1N5346A | | 1N5374B | | 1N5524A | | 1N5760A | | 1N5917 | | 1N5945 | |
| 1N5346B | | 1N5375 | 4-78 | 1N5524B | | 1N5761 | | 1N5917A | | 1N5945A | |
| 1N5347 | 4-78 | 1N5375A | | 1N5525 | 4-77 | 1N5761A | | 1N5917B | | 1N5945B | |
| 1N5347A | | 1N5375B | | 1N5525A | | 1N5762 | | 1N5918 | | 1N5946 | |
| 1N5347B | | 1N5376 | | 1N5525B | | 1N5762A | | 1N5918A | | 1N5946A | |
| 1N5348 | 4-78 | 1N5376A | | 1N5526 | 4-77 | | | 1N5918B | | 1N5946B | |
| 1N5348A | | 1N5376B | | 1N5526A | | 4-Layer Diodes | | 1N5919 | | 1N5947 | |
| 1N5348B | | 1N5377 | 4-78 | 1N5526B | | 1N5779 | | 1N5919A | | 1N5947A | |
| 1N5349 | 4-78 | 1N5377A | | 1N5527 | 4-77 | 1N5780 | | 1N5919B | | 1N5947B | |
| 1N5349A | | 1N5377B | | 1N5527A | | 1N5781 | | 1N5920 | | 1N5948 | |
| 1N5349B | | 1N5378 | 4-78 | 1N5527B | | 1N5782 | | 1N5920A | | 1N5948A | |
| 1N5350 | 4-78 | 1N5378A | | 1N5528 | 4-77 | 1N5783 | | 1N5920B | | 1N5948B | |
| 1N5350A | | 1N5378B | | 1N5528A | | 1N5784 | | 1N5921 | | 1N5949 | |
| 1N5350B | | 1N5379 | 4-78 | 1N5528B | | 1N5785 | | 1N5921A | | 1N5949A | |
| 1N5351 | | 1N5379A | | 1N5529 | 4-77 | 1N5786 | | 1N5921B | | 1N5949B | |
| 1N5351A | | 1N5379B | | 1N5529A | | 1N5787 | | 1N5922 | | 1N5950 | |
| 1N5351B | | 1N5380 | 4-78 | 1N5529B | | 1N5788 | | 1N5922A | | 1N5950A | |
| 1N5352 | 4-78 | 1N5380A | | 1N5530 | 4-77 | 1N5789 | | 1N5922B | | 1N5950B | |
| 1N5352A | | 1N5380B | | 1N5530A | | 1N5790 | | 1N5923 | | 1N5951 | |
| 1N5352B | | 1N5381 | 4-78 | 1N5530B | | 1N5791 | | 1N5923A | | 1N5951A | |
| 1N5353 | 4-78 | 1N5381A | | 1N5531 | 4-77 | 1N5792 | | 1N5923B | | 1N5951B | |
| 1N5353A | | 1N5381B | | 1N5531A | | 1N5793 | | 1N5924 | | 1N5952 | |
| 1N5353B | | 1N5382 | | 1N5531B | | RECTIFIERS | | 1N5924A | | 1N5952A | |
| 1N5354 | 4-78 | 1N5382A | | 1N5532 | 4-77 | Schottky | | 1N5924B | | 1N5952B | |
| 1N5354A | | 1N5382B | | 1N5532A | | 1N5817 | | 1N5925 | | 1N5953 | |
| 1N5354B | | 1N5383 | 4-78 | 1N5532B | | 1N5818 | | 1N5925A | | 1N5953A | |
| 1N5355 | | 1N5383A | | 1N5533 | 4-77 | | | 1N5925B | | 1N5953B | |
| 1N5355A | | | | | | | | | | | |

| DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE |
|---------|------|--------------------|-------|--------------------|-------|--------------------|-------|--------------------|-------|
| 1N5954 | | 1N6010 | 4-77 | 2N691 | 4-101 | 2N1523 | | 2N218AJTX2 | |
| 1N5954A | | 1N6010A | | 2N692 | 4-101 | 2N1529 | | 2N2219s | 4-15 |
| 1N5954B | | 1N6010B | | | | 2N1530 | | 2N2219JAN1 | |
| 1N5955 | | 1N6011 | 4-77 | TRANSISTORS | | 2N1531 | | 2N2219JAN2 | |
| 1N5955A | | 1N6011A | | SS Metal | | 2N1532 | | 2N2219JTX1 | |
| 1N5955B | | 1N6011B | | 2N697 | 4-15 | 2N1533 | | 2N2219JTX2 | |
| 1N5956 | | 1N6012 | 4-77 | 2N699 | 4-19 | 2N1534 | | 2N2219As | 4-15 |
| 1N5956A | | 1N6012A | | 2N703 | | 2N1535 | | 2N2219AJAN1 | |
| 1N5956B | | 1N6012B | | 2N703JAN | | 2N1536 | | 2N2219AJAN2 | |
| 1N5958 | 4-77 | 1N6013 | 4-77 | 2N706 | | 2N1537 | | 2N2219AJTX1 | |
| 1N5958A | | 1N6013A | | 2N706JAN | | 2N1538 | | 2N2219AJTX2 | |
| 1N5958B | | 1N6013B | | 2N706A | | 2N1539 | | 2N2221 | 4-19 |
| 1N5958C | 4-77 | 1N6014 | 4-77 | 2N706B | | 2N1540 | | 2N2221JAN | |
| 1N5958D | | 1N6014A | | 2N708 | | 2N1541 | | 2N2221JTX | |
| 1N5958E | | 1N6014B | | 2N708JAN | | 2N1542 | | 2N2221A | 4-19 |
| 1N5958F | 4-77 | 1N6015 | 4-77 | 2N708JTX | | | | 2N2221AJAN | |
| 1N5958G | | 1N6015A | | 2N717 | 4-19 | THYRISTORS | | 2N2221AJTX | |
| 1N5958H | | 1N6015B | | 2N718 | 4-19 | SCR | | 2N2222 | 4-19 |
| 1N5958I | 4-77 | 1N6016 | 4-77 | 2N718A | | 2N1595 | 4-100 | 2N2222JAN | |
| 1N5958J | | 1N6016A | | 2N718AJAN | | 2N1596 | 4-100 | 2N2222JTX | |
| 1N5958K | | 1N6016B | | 2N718AJTX | | 2N1597 | 4-100 | 2N2222A | 4-19 |
| 1N5958L | 4-77 | 1N6017 | 4-77 | 2N720A | | 2N1598 | 4-100 | 2N2222AJAN | |
| 1N5958M | | 1N6017A | | 2N736 | | 2N1599 | 4-100 | 2N2222AJTX | |
| 1N5958N | | 1N6017B | | 2N740 | | | | 2N2223 | 4-42 |
| 1N5958O | 4-77 | 1N6018 | 4-77 | 2N744 | | TRANSISTORS | | 2N2223A | 4-42 |
| 1N5958P | | 1N6018A | | 2N753 | | SS Metal | | 2N2257 | |
| 1N5958Q | | 1N6018B | | 2N828A | | 2N1613 | 4-19 | 2N2270 | |
| 1N5958R | 4-77 | 1N6019 | 4-77 | 2N843 | 4-19 | 2N1613As | | 2N2270s | 4-19 |
| 1N5958S | | 1N6019A | | 2N859A | 4-16 | 2N1613s | 4-15 | 2N2270s | 4-19 |
| 1N5958T | | 1N6019B | | 2N869AJAN | | 2N1613JAN1 | | 2N2270s | 4-19 |
| 1N5958U | 4-77 | 1N6020 | 4-77 | 2N869AJTX | | 2N1613JAN2 | | 2N2319 | |
| 1N5958V | | 1N6020A | | 2N910 | | 2N1613JTX1 | | | |
| 1N5958W | | 1N6020B | | 2N914 | | 2N1613JTX2 | | THYRISTORS | |
| 1N5958X | 4-77 | 1N6021 | 4-77 | 2N914AJAN | | 2N1711As | | SCR | |
| 1N5958Y | | 1N6021A | | 2N914JTX | | 2N1711s | 4-15 | 2N2322 | 4-100 |
| 1N5958Z | | 1N6021B | | 2N915 | 4-15 | | | 2N2324 | 4-100 |
| 1N5959 | 4-77 | 1N6022 | 4-77 | 2N916 | 4-15 | THYRISTORS | | 2N2325 | 4-100 |
| 1N5959A | | 1N6022A | | 2N916AJAN | | SCR | | 2N2326 | 4-100 |
| 1N5959B | | 1N6022B | | 2N917 | 4-18 | 2N1842 | 4-100 | 2N2327 | 4-100 |
| 1N5959C | 4-77 | 1N6023 | 4-77 | 2N918 | 4-18 | 2N1842A | 4-100 | 2N2328 | 4-100 |
| 1N5959D | | 1N6023A | | 2N918AJAN | | 2N1843 | 4-100 | 2N2329 | 4-100 |
| 1N5959E | | 1N6023B | | 2N918AJTX | | 2N1843A | 4-100 | | |
| 1N5959F | 4-77 | 1N6024 | 4-77 | 2N929 | 4-17 | 2N1844 | 4-100 | TRANSISTORS | |
| 1N5959G | | 1N6024A | | 2N929AJAN | | 2N1844A | 4-100 | SS Metal | |
| 1N5959H | | 1N6024B | | 2N930 | 4-17 | 2N1845 | 4-100 | 2N2330 | |
| 1N5959I | 4-77 | 1N6025 | 4-77 | 2N930A | 4-17 | 2N1845A | 4-100 | 2N2331 | |
| 1N5959J | | 1N6025A | | 2N930AJAN | | 2N1846 | 4-100 | 2N2368 | 4-15 |
| 1N5959K | | 1N6025B | | 2N956 | | 2N1846A | 4-100 | 2N2369 | 4-15 |
| 1N5959L | 4-77 | 1N6026 | 4-77 | 2N998 | 4-45 | 2N1847 | 4-100 | 2N2369A | 4-15 |
| 1N5959M | | 1N6026A | | 2N1131 | 4-16 | 2N1847A | 4-100 | 2N2369AJAN | |
| 1N5959N | | 1N6026B | | 2N1131A | 4-16 | 2N1848 | 4-100 | 2N2369AJTX | |
| 1N5959O | 4-77 | 1N6027 | 4-77 | 2N1131S | 4-20 | 2N1848A | 4-100 | 2N2382 | |
| 1N5959P | | 1N6027A | | 2N1131As | 4-20 | 2N1849 | 4-100 | 2N2405s | |
| 1N5959Q | 4-77 | 1N6027B | | 2N1131JAN | | 2N1849A | 4-100 | 2N2453 | |
| 1N6000 | | 1N6028 | 4-77 | 2N1132 | 4-16 | 2N1850 | 4-100 | 2N2453A | |
| 1N6000A | | 1N6028A | | 2N1132A | 4-16 | 2N1850A | 4-100 | 2N2480 | 4-42 |
| 1N6000B | | 1N6028B | | 2N1132S | 4-20 | | | 2N2480A | 4-42 |
| 1N6001 | 4-77 | 1N6029 | 4-77 | 2N1132As | 4-20 | TRANSISTORS | | 2N2481 | |
| 1N6001A | | 1N6029A | | 2N1132JAN | | SS Metal | | 2N2481JAN | |
| 1N6001B | | 1N6029B | | | | 2N1890 | | 2N2481JTX | |
| 1N6002 | 4-77 | 1N6030 | 4-77 | Pwr | | 2N1893s | 4-19 | 2N2483 | 4-17 |
| 1N6002A | | 1N6030A | | 2N1162 | | 2N1990s | 4-17 | 2N2484 | 4-17 |
| 1N6002B | | 1N6030B | | 2N1163 | | 2N1991s | 4-16 | 2N2501 | |
| 1N6003 | 4-77 | 1N6031 | 4-77 | 2N1164 | | | | 2N2539 | 4-15 |
| 1N6003A | | 1N6031A | | 2N1165 | | Met Dual | | 2N2540 | 4-15 |
| 1N6003B | | 1N6031B | | 2N1166 | | 2N2060 | 4-42 | 2N2543A | 4-41 |
| 1N6004 | 4-77 | | | 2N1167 | | 2N2060A | 4-42 | | |
| 1N6004A | | TRANSISTORS | | 2N1190s | | 2N2060JAN | | THYRISTORS | |
| 1N6004B | | SS Metal | | 2N1191 | | 2N2060JTX | | SCR | |
| 1N6005 | 4-77 | 2N656s | 4-19 | 2N1192 | | 2N2060JTXV | | 2N2573 | 4-101 |
| 1N6005A | | 2N657s | 4-17 | 2N1193 | | | | 2N2574 | 4-101 |
| 1N6005B | | | | 2N1194 | | SS Metal | | 2N2575 | 4-101 |
| 1N6006 | 4-77 | THYRISTORS | | 2N1358 | | 2N2102s | 4-19 | 2N2576 | 4-101 |
| 1N6006A | | SCR | | 2N1359 | | 2N2193As | 4-19 | 2N2577 | 4-101 |
| 1N6006B | | 2N681 | 4-101 | 2N1360 | | 2N2206 | 4-15 | 2N2578 | 4-101 |
| 1N6007 | 4-77 | 2N682 | 4-101 | 2N1362 | | 2N2218s | 4-15 | 2N2579 | 4-101 |
| 1N6007A | | 2N683 | 4-101 | 2N1363 | | 2N2218JAN1 | | | |
| 1N6007B | | 2N684 | 4-101 | 2N1364 | | 2N2218JAN2 | | TRANSISTORS | |
| 1N6008 | 4-77 | 2N685 | 4-101 | 2N1365 | | 2N2218JTX1 | | Met Dual | |
| 1N6008A | | 2N686 | 4-101 | 2N1518 | | 2N2218JTX2 | | 2N2639 | 4-41 |
| 1N6008B | | 2N687 | 4-101 | 2N1519 | | 2N2218As | 4-15 | 2N2640 | 4-41 |
| 1N6009 | 4-77 | 2N688 | 4-101 | 2N1520 | | 2N2218AJAN1 | | 2N2641 | 4-41 |
| 1N6009A | | 2N689 | 4-101 | 2N1521 | | 2N2218AJAN2 | | 2N2642 | 4-41 |
| 1N6009B | | 2N690 | 4-101 | 2N1522 | | 2N2218AJTX1 | | 2N2643 | 4-41 |
| | | | | | | | | 2N2644 | 4-41 |

CATALOG INDEX (continued)

| DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE |
|-----------------|------|------------------|------|-------------------|------|--------------------|------|--------------------|-------|-------------------|-------|
| RF | | RF | | 2N3506JTX1 | | Pwr Metal | | RF | | RF | |
| 2N2947 | | 2N3375 | | 2N3506JTX2 | | 2N3738 | 4-3 | 2N3839 | 4-59 | 2N4012 | |
| 2N2948 | | 2N3375JAN | | 2N3506JTXV | | 2N3739 | 4-3 | 2N3865 | 4-58 | Met Dual | |
| 2N2949 | | 2N3375JTX | | 2N3507 | 4-15 | 2N3739JAN | | 2N3866A | | 2N4013 | 4-15 |
| 2N2950 | | | | 2N3507JAN1 | | 2N3739JTX | | 2N3866JAN | | 2N4014 | 4-15 |
| | | | | 2N3507JAN2 | | 2N3740 | | 2N3866JTX | | 2N4015 | 4-42 |
| | | | | 2N3507JTX1 | | 2N3740A | | 2N3866AJAN | | 2N4016 | 4-42 |
| | | | | 2N3507JTX2 | | 2N3740JAN | | 2N3866AJTX | | | |
| SS Metal | | SS Metal | | 2N3507JTXV | | 2N3740JTXV | | Pwr Metal | | Pwr | |
| 2N2951s | 4-15 | 2N3425 | | 2N3508 | 4-15 | 2N3741 | 4-4 | 2N3867 | 4-4 | 2N4048 | |
| 2N2959s | 4-15 | Power | | 2N3509 | 4-15 | 2N3741A | | 2N3867JAN | | 2N4049 | |
| 2N3009 | | 2N3427 | | 2N3510 | | 2N3741A | | 2N3867JTX | | 2N4050 | |
| 2N3011 | 4-15 | Fet | | 2N3511 | | 2N3741JAN | | 2N3867JTXV | | 2N4051 | |
| 2N3012 | 4-16 | 2N3436 | | 2N3544 | 4-18 | 2N3741JTX | | 2N3868 | 4-4 | 2N4052 | |
| 2N3013 | | 2N3437 | | 2N3546 | 4-16 | 2N3741JTXV | | 2N3868JAN | | 2N4053 | |
| 2N3013JAN | | 2N3438 | | | | | | 2N3868JTX | | Fet | |
| 2N3014 | | | | RF | | SS Metal | | 2N3868JTXV | | 2N4066 | |
| 2N3019s | 4-19 | Pwr Metal | | 2N3553 | 4-58 | 2N3742s | 4-17 | THYRISTORS | | 2N4067 | |
| 2N3020s | 4-19 | 2N3439 | 4-3 | 2N3553JAN | | 2N3743s | 4-18 | SCR | | | |
| 2N3043 | 4-41 | 2N3439s | | 2N3553JTX | | 2N3743JAN | | 2N3870 | 4-101 | RF | |
| 2N3044 | 4-41 | 2N3440 | 4-3 | Pwr Metal | | 2N3743JTX | | 2N3871 | 4-101 | 2N4072 | |
| 2N3045 | 4-41 | 2N3440s | | 2N3553 | | 2N3743JTXV | | 2N3872 | 4-101 | 2N4073 | |
| 2N3046 | 4-41 | 2N3441 | | 2N3584 | 4-10 | 2N3762s | 4-16 | 2N3873 | 4-101 | Fet | |
| 2N3047 | 4-41 | 2N3442 | | RF | | 2N3763s | 4-16 | 2N3874 | 4-101 | 2N4091 | 4-32 |
| 2N3048 | 4-41 | | | 2N3585 | 4-9 | 2N3764 | | 2N3896 | 4-101 | 2N4092 | 4-32 |
| 2N3053s | | SS Metal | | 2N3632 | | Pwr Metal | | 2N3897 | 4-101 | 2N4093 | 4-32 |
| 2N3053As | 4-19 | 2N3444s | 4-15 | SS Metal | | 2N3766 | | 2N3898 | 4-101 | | |
| 2N3054A | 4-6 | 2N3444JAN | | 2N3634s | 4-16 | 2N3767 | | 2N3899 | 4-101 | SS Plastic | |
| 2N3072s | | Pwr Metal | | 2N3634JAN1 | | 2N3773 | | TRANSISTORS | | 2N4123 | 4-24 |
| 2N3073 | 4-16 | 2N3445 | | 2N3634JAN2 | | 2N3778 | | Pwr Metal | | 2N4124 | 4-24 |
| 2N3110s | 4-19 | 2N3446 | | 2N3634JTX1 | | 2N3789NS | | 2N3902 | 4-9 | 2N4124 | 4-24 |
| 2N3114s | 4-17 | 2N3447 | | 2N3634JTX2 | | 2N3790NS | | 2N3902JAN | | 2N4126 | 4-24 |
| 2N3133s | 4-16 | 2N3448 | | 2N3635s | 4-16 | 2N3791 | 4-6 | 2N3902JTX | | | |
| 2N3135 | 4-16 | | | 2N3635JAN1 | | 2N3791JAN | | Pwr Plastic | | RF | |
| RF | | SS Metal | | 2N3635JAN2 | | 2N3791JTX | | 2N3903 | 4-24 | 2N4130 | |
| 2N3137 | | 2N3467s | 4-16 | 2N3635JTX1 | | 2N3791NS | | 2N3904 | 4-24 | THYRISTORS | |
| SS Metal | | 2N3467JAN1 | | 2N3635JTX2 | | 2N3792 | 4-6 | 2N3905 | 4-24 | SCR | |
| 2N3220 | | 2N3467JAN2 | | 2N3635JTXV | 4-16 | 2N3792JAN | | 2N3906 | 4-24 | 2N4167 | 4-100 |
| 2N3227 | 4-15 | 2N3467JTX2 | | 2N3636JAN1 | | 2N3792JTX | | Fet | | 2N4168 | 4-100 |
| 2N3244s | 4-16 | 2N3468s | 4-16 | 2N3636JAN2 | | 2N3792NS | | 2N3909 | 4-31 | 2N4169 | 4-100 |
| 2N3245s | 4-16 | 2N3468JAN1 | | 2N3636JTX1 | | SS Metal | | 2N3909A | 4-31 | 2N4170 | 4-100 |
| 2N3249 | 4-16 | 2N3468JAN2 | | 2N3636JTX2 | | 2N3798 | 4-17 | RF | | 2N4171 | 4-100 |
| 2N3250 | 4-16 | 2N3468JTX1 | | 2N3636JTXV | 4-15 | 2N3799 | 4-17 | 2N3924 | | 2N4172 | 4-100 |
| 2N3250A | 4-16 | 2N3468JTX2 | | 2N3637 | 4-18 | 2N3806 | 4-41 | 2N3925 | | 2N4173 | 4-100 |
| 2N3250AJAN | | 2N3485 | 4-20 | 2N3637JAN1 | | 2N3807 | 4-41 | 2N3926 | | 2N4174 | 4-100 |
| 2N3250AJTX | | 2N3485A | 4-20 | 2N3637JAN2 | | 2N3808 | 4-41 | 2N3927 | | 2N4183 | 4-100 |
| 2N3251 | 4-16 | 2N3486 | 4-20 | 2N3637JTX1 | | 2N3809 | 4-41 | SS Metal | | 2N4184 | 4-100 |
| 2N3251A | 4-16 | 2N3486A | 4-20 | 2N3637JTX2 | | 2N3810 | 4-41 | 2N3946 | 4-15 | 2N4185 | 4-100 |
| 2N3251AJAN | | 2N3486AJAN | | 2N3637JTXV | 4-15 | 2N3810A | | 2N3947 | 4-15 | 2N4186 | 4-100 |
| 2N3251AJTX | | 2N3486AJTX | | 2N3637s | 4-17 | 2N3810JAN | | RF | | 2N4187 | 4-100 |
| 2N3252s | 4-15 | 2N3494s | 4-18 | 2N3637JTX1 | | 2N3810JTX | | 2N3948 | 4-55 | 2N4188 | 4-100 |
| 2N3253s | 4-15 | 2N3495s | 4-18 | 2N3637JTX2 | | 2N3810JTXV | | 2N3950 | | 2N4189 | 4-100 |
| 2N3253JAN | | 2N3496 | 4-18 | 2N3637s | 4-17 | 2N3811 | 4-41 | 2N3959 | 4-60 | 2N4190 | 4-100 |
| 2N3263 | | 2N3497 | 4-18 | Pwr Metal | | 2N3811A | | 2N3960 | | Pulse | |
| 2N3284 | | 2N3498 | 4-17 | 2N3713 | | 2N3811JAN | | 2N3960JAN | | Modulator | |
| 2N3285 | | 2N3498s | 4-17 | 2N3713NS | | 2N3811JTX | | 2N3960JTX | | 2N4199 | 4-103 |
| RF | | 2N3498JAN1 | | 2N3714 | | 2N3811JTXV | | 2N3961 | | 2N4199JAN | 4-103 |
| 2N3287 | | 2N3498JAN2 | | 2N3714NS | | 2N3811JTXV | | Fet | | 2N4200 | 4-103 |
| 2N3291 | | 2N3498JTX1 | | 2N3715 | 4-6 | 2N3812 | 4-41 | 2N3970 | 4-32 | 2N4200JAN | 4-103 |
| 2N3292 | | 2N3498JTX2 | | 2N3715HS | | 2N3813 | 4-41 | 2N3971 | 4-32 | 2N4201 | 4-103 |
| 2N3294 | | 2N3498JTXV | | 2N3715JAN | | 2N3814 | 4-41 | 2N3972 | 4-32 | 2N4201JAN | 4-103 |
| 2N3295s | | 2N3499s | 4-17 | 2N3715JTXV | | 2N3815 | 4-41 | | | 2N4202 | 4-103 |
| 2N3296 | | 2N3499JAN1 | | 2N3716 | 4-6 | 2N3816 | 4-41 | SS Metal | | 2N4202JAN | 4-103 |
| 2N3297 | | 2N3499JAN2 | | 2N3716S | | 2N3816A | 4-41 | 2N3978 | | 2N4203 | 4-103 |
| SS Metal | | 2N3499JTX1 | | 2N3716JAN | | 2N3817 | 4-41 | THYRISTORS | | 2N4203JAN | 4-103 |
| 2N3299s | 4-15 | 2N3499JTX2 | | 2N3716JTX | | 2N3817A | 4-41 | Unijunction | | 2N4204 | 4-103 |
| 2N3300s | 4-15 | 2N3499JTXV | | 2N3719 | | TRANSISTORS | | Fet | | 2N4204JAN | 4-103 |
| 2N3301 | 4-19 | 2N3500s | 4-17 | 2N3720 | | 2N3980 | | 2N3993 | 4-32 | SS Metal | |
| 2N3302 | 4-19 | 2N3500JAN1 | | SS Metal | | 2N3982 | 4-31 | 2N3994 | 4-32 | 2N4208 | 4-16 |
| 2N3303 | | 2N3500JAN2 | | 2N3724 | 4-15 | 2N3983 | 4-30 | 2N3994A | 4-32 | 2N4209 | 4-16 |
| 2N3307 | 4-18 | 2N3500JTX1 | | 2N3725 | 4-15 | 2N3984 | 4-30 | | | THYRISTORS | |
| 2N3308 | 4-18 | 2N3500JTX2 | | 2N3726 | | SS Oval | | | | 2N4212 | 4-100 |
| | | 2N3500JTXV | | 2N3727 | | 2N3838 | 4-42 | | | 2N4213 | 4-100 |
| Fet | | 2N3500JTXV | 4-17 | 2N3727 | | | | | | 2N4214 | 4-100 |
| 2N3330 | 4-31 | 2N3501JAN1 | | 2N3734 | 4-15 | | | | | 2N4215 | 4-100 |
| 2N3330JAN | | 2N3501JAN2 | | 2N3735 | 4-15 | | | | | | |
| 2N3330JTX | | 2N3501JTX1 | | 2N3736 | 4-15 | | | | | | |
| 2N3365 | 4-31 | 2N3501JTX2 | | 2N3737 | 4-15 | | | | | | |
| 2N3366 | 4-31 | 2N3501JTXV | 4-15 | | | | | | | | |
| 2N3367 | 4-31 | 2N3506JAN1 | | | | | | | | | |
| | | 2N3506JAN2 | | | | | | | | | |

CATALOG INDEX (continued)

| DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE |
|-------------|-------|-------------|-------|----------------------|-------|-------------|-------|-------------|-------|-------------|-------|
| 2N4216 | 4-100 | THYRISTORS | | SS Metal | | RF | | 2N5336 | | THYRISTORS | |
| 2N4217 | 4-100 | SCR | | 2N4924s | 4-17 | 2N5090 | | 2N5337 | | Triac | |
| 2N4218 | 4-100 | 2N4441 | 4-98 | 2N4925s | | 2N5108 | 4-59 | 2N5338 | | 2N5567 | 4-102 |
| 2N4219 | 4-100 | 2N4442 | 4-98 | 2N4926 | 4-17 | 2N5109 | 4-60 | 2N5339 | | 2N5568 | 4-102 |
| TRANSISTORS | | 2N4443 | 4-98 | 2N4927 | 4-17 | SS Quad | | 2N5344 | | 2N5569 | 4-102 |
| Fet | | 2N4444 | 4-98 | 2N4928s | 4-18 | 2N5146 | | 2N5345 | | 2N5570 | 4-102 |
| 2N4220 | 4-30 | TRANSISTORS | | 2N4929s | 4-16 | Pwr Metal | | 2N5346 | | 2N5571 | 4-102 |
| 2N4220A | 4-31 | SS Metal | | 2N4930s | 4-18 | 2N5155 | | 2N5347 | | 2N5572 | 4-102 |
| 2N4221 | 4-30 | 2N4449JAN | | 2N4930JAN | | 2N5157 | | 2N5348 | | 2N5573 | 4-102 |
| 2N4221A | 4-31 | 2N4449JTX | | 2N4930JTX | | RF | | 2N5349 | | 2N5574 | 4-102 |
| 2N4222 | 4-30 | 2N4449JTX | | 2N4931s | 4-18 | 2N5160 | 4-60 | Fet | | TRANSISTORS | |
| 2N4222A | 4-31 | 2N4450 | 4-15 | 2N4931JAN | | 2N5161 | | 2N5358 | 4-31 | SS Metal | |
| 2N4223 | 4-33 | 2N4453 | | 2N4931JTX | | 2N5162 | | 2N5359 | 4-31 | 2N5581 | 4-15 |
| 2N4224 | 4-33 | THYRISTORS | | 2N4931JTX | | THYRISTORS | | 2N5360 | 4-31 | 2N5581JAN | |
| Pwr Metal | | Unijunction | | 2N4931JTX | | SCR | | 2N5361 | 4-31 | 2N5582JTX | 4-15 |
| 2N4231A | 4-5 | 2N4851 | 4-104 | 2N4938 | | 2N5164 | 4-100 | 2N5362 | 4-31 | RF | |
| 2N4232A | 4-5 | 2N4852 | 4-104 | 2N4939 | | 2N5165 | 4-100 | 2N5363 | 4-31 | 2N5583 | 4-60 |
| 2N4233A | 4-5 | 2N4853 | 4-104 | 2N4940 | | 2N5166 | 4-100 | 2N5364 | 4-31 | 2N5589 | 4-54 |
| 2N4234s | | TRANSISTORS | | 2N4941 | | 2N5167 | 4-100 | SS Plastic | | 2N5590 | 4-54 |
| 2N4235s | | SS Metal | | 2N4942 | | 2N5168 | 4-100 | 2N5400 | 4-24 | 2N5591 | 4-55 |
| 2N4236s | | 2N4854 | 4-42 | THYRISTORS | | 2N5169 | 4-100 | 2N5401 | 4-24 | Fet | |
| 2N4237s | | 2N4854JAN | | Unijunction | | 2N5170 | 4-100 | Pwr Metal | | 2N5594 | |
| 2N4238s | | 2N4854JTX | | 2N4948 | 4-104 | 2N5171 | 4-100 | 2N5427 | | 2N5629 | 4-6 |
| 2N4239s | | 2N4854JTXV | | 2N4949 | 4-104 | TRANSISTORS | | 2N5428 | | 2N5630 | 4-6 |
| 2N4240 | 4-3 | 2N4855 | 4-42 | 2N4949JAN | | RF | | 2N5429 | | 2N5631 | 4-6 |
| SS Metal | | Fet | | 2N4949JTX | | 2N5179 | 4-59 | THYRISTORS | | 2N5632 | 4-6 |
| 2N4260 | 4-18 | 2N4856 | 4-32 | TRANSISTORS | | Pwr Plastic | | Unijunction | | 2N5633 | 4-6 |
| 2N4261 | 4-18 | 2N4856A | 4-32 | RF | | 2N5190 | 4-4 | 2N5431 | 4-104 | 2N5634 | 4-6 |
| 2N4264 | 4-25 | 2N4856JAN | | 2N4957 | 4-59 | 2N5191 | 4-4 | 2N5431JAN | | 2N5635 | 4-58 |
| 2N4265 | 4-25 | 2N4856JTX | | 2N4957JAN | | 2N5192 | 4-4 | 2N5431JANX | | 2N5636 | 4-58 |
| Pwr | | 2N4857 | 4-32 | 2N4957JTX | | 2N5193 | 4-4 | TRANSISTORS | | 2N5637 | 4-58 |
| 2N4276 | | 2N4857A | 4-32 | 2N4957JTXV | | 2N5194 | 4-4 | Pwr | | Fet | |
| 2N4277 | | 2N4858 | 4-32 | 2N4958 | 4-59 | 2N5195 | 4-4 | 2N5435 | | 2N5638 | 4-32 |
| 2N4278 | | 2N4858A | 4-32 | 2N4959 | 4-59 | SS Plastic | | 2N5436 | | 2N5639 | 4-32 |
| 2N4279 | | 2N4859 | 4-32 | THYRISTORS | | 2N5208 | | 2N5437 | | 2N5640 | 4-32 |
| 2N4280 | | 2N4859A | 4-32 | Bidirectional Switch | | 2N5209 | 4-27 | 2N5438 | | RF | |
| 2N4281 | | 2N4859JAN | | 2N4993 | | 2N5210 | 4-27 | 2N5439 | | 2N5641 | 4-58 |
| 2N4282 | | 2N4859JTX | | TRANSISTORS | | 2N5219 | | 2N5440 | | 2N5642 | 4-58 |
| 2N4283 | | Fet | | RF | | 2N5220 | 4-26 | THYRISTORS | | 2N5643 | 4-58 |
| 2N4342 | 4-31 | 2N4860 | 4-32 | 2N5016 | | 2N5221 | 4-26 | Triac | | 2N5644 | 4-55 |
| Pwr Metal | | 2N4860A | 4-32 | 2N5031 | 4-59 | 2N5222 | | 2N5441 | | 2N5645 | |
| 2N4348 | | 2N4861 | 4-32 | 2N5032 | 4-59 | 2N5223 | | 2N5442 | | 2N5646 | |
| Fet | | 2N4861A | 4-32 | Pwr Metal | | 2N5224 | | 2N5443 | | | |
| 2N4351 | 4-30 | THYRISTORS | | 2N5050 | | 2N5225 | 4-26 | 2N5444 | | | |
| 2N4352 | 4-30 | Unijunction | | 2N5051 | | 2N5226 | 4-26 | 2N5445 | | | |
| 2N4356 | 4-31 | 2N4870 | 4-104 | 2N5052 | | 2N5227 | | 2N5446 | | | |
| 2N4391 | 4-32 | 2N4871 | 4-104 | SS Metal | | 2N5228 | | TRANSISTORS | | | |
| 2N4392 | 4-32 | TRANSISTORS | | 2N5058s | 4-17 | 2N5229 | | Fet | | | |
| 2N4393 | 4-32 | Pwr Metal | | 2N5059s | 4-17 | 2N5230 | | 2N5653 | | | |
| Pwr Metal | | 2N4877 | | THYRISTORS | | 2N5231 | | 2N5654 | | | |
| 2N4398 | 4-7 | SS Metal | | SCR | | Pwr Metal | | 2N5655 | 4-3 | | |
| 2N4398HS | | 2N4890 | 4-16 | 2N5060 | | 2N5241 | | 2N5656 | 4-3 | | |
| 2N4399 | 4-7 | Pwr Metal | | 2N5061 | | Fet | | 2N5657 | 4-3 | | |
| 2N4399HS | | 2N4898 | | 2N5062 | | 2N5265 | 4-31 | 2N5668 | 4-33 | | |
| 2N4399JAN | | 2N4899 | | 2N5063 | | 2N5266 | 4-31 | 2N5669 | 4-28 | | |
| 2N4399JTX | | 2N4900 | | 2N5064 | | 2N5267 | 4-31 | 2N5670 | 4-33 | | |
| 2N4399JTXV | | 2N4901 | | THYRISTORS | | 2N5268 | 4-31 | Pwr Plastic | | | |
| SS Plastic | | 2N4902 | | SCR | | 2N5269 | 4-31 | 2N5679s | | | |
| 2N4400 | 4-24 | 2N4903 | | 2N5067 | | 2N5270 | 4-31 | 2N5680 | | | |
| 2N4401 | 4-24 | 2N4904 | | 2N5068 | | 2N5271 | | 2N5680s | | | |
| 2N4402 | 4-24 | 2N4905 | | 2N5069 | | Pwr Metal | | 2N5681 | | | |
| 2N4403 | 4-24 | 2N4906 | | RF | | 2N5301 | 4-7 | 2N5681s | | | |
| 2N4404 | 4-16 | 2N4910 | | 2N5070 | 4-57 | 2N5301HS | | 2N5682 | | | |
| 2N4405 | 4-16 | 2N4911 | | 2N5071 | | 2N5302 | 4-7 | 2N5682s | | | |
| 2N4406 | 4-16 | 2N4912 | | SS Plastic | | 2N5302HS | | 2N5683 | 4-7 | | |
| 2N4407 | 4-16 | 2N4913 | | 2N5086 | 4-24 | 2N5302JAN | | 2N5684 | 4-7 | | |
| 2N4409 | | 2N4914 | | 2N5087 | 4-24 | 2N5302JTX | | 2N5685 | 4-7 | | |
| 2N4410 | | 2N4915 | 4-4 | 2N5088 | 4-24 | 2N5303 | 4-6 | 2N5685JAN | | | |
| 2N4416 | 4-33 | 2N4918 | 4-4 | 2N5089 | 4-24 | 2N5303HS | | 2N5686 | 4-7 | | |
| 2N4416A | 4-33 | 2N4919 | 4-4 | THYRISTORS | | 2N5303JAN | | 2N5686JTX | | | |
| RF | | 2N4920 | 4-4 | SCR | | 2N5303JTX | | | | | |
| 2N4427 | 4-54 | 2N4921 | 4-4 | 2N5086 | 4-24 | 2N5304 | 4-6 | | | | |
| 2N4428 | 4-60 | 2N4922 | 4-4 | 2N5087 | 4-24 | 2N5324 | | | | | |
| 2N4440 | | 2N4923 | 4-4 | 2N5088 | 4-24 | 2N5325 | | | | | |

| DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE |
|----------------|-------|-------------|------|-------------|-------|-------------|------|-------------|------|-------------|------|
| Fet | | RF | | 2N5072A | 4-99 | 2N6191 | | 2N6344 | 4-99 | 2N6443 | 4-41 |
| 2N5716 | 4-31 | 2N5941 | 4-57 | 2N6072B | 4-99 | 2N6192 | | 2N6344A | 4-99 | 2N6444 | 4-41 |
| 2N5717 | 4-31 | 2N5942 | 4-57 | 2N5073 | 4-99 | 2N6193 | | 2N6345 | 4-99 | 2N6445 | 4-41 |
| 2N5718 | 4-31 | 2N5943 | 4-60 | 2N6073A | 4-99 | 2N6211 | | 2N6345A | 4-99 | 2N6446 | 4-41 |
| Pwr Metal | | 2N5944 | 4-55 | 2N6073B | 4-99 | 2N6212 | | 2N6346 | 4-99 | 2N6447 | 4-41 |
| 2N5745 | 4-6 | 2N5945 | 4-55 | 2N6074 | 4-99 | 2N6213 | | 2N6346A | 4-99 | 2N6448 | 4-41 |
| 2N5745HS | | 2N5946 | 4-55 | 2N6074A | 4-99 | 2N6226 | 4-5 | 2N6347 | 4-99 | Pwr Metal | |
| 2N5745JAN | | 2N5947 | | 2N6074B | 4-99 | 2N6227 | 4-5 | 2N6347A | 4-99 | 2N6495 | 4-11 |
| 2N5745JIX | | Pwr Plastic | | 2N5075 | 4-99 | 2N6228 | 4-5 | 2N6348 | 4-99 | Pwr Plastic | |
| 2N5745JIXV | | 2N5973 | 4-42 | 2N6075A | 4-99 | 2N6229 | 4-6 | 2N6348A | 4-99 | 2N6497 | 4-5 |
| 2N5758 | 4-5 | 2N5974 | 4-42 | 2N6075B | 4-99 | 2N6230 | 4-6 | 2N6349 | 4-99 | 2N6498 | 4-5 |
| 2N5759 | 4-5 | 2N5975 | 4-42 | 2N6075B | 4-99 | 2N6231 | 4-6 | 2N6349A | 4-99 | 2N6499 | 4-5 |
| 2N5760 | 4-5 | 2N5976 | 4-42 | TRANSISTORS | | 2N6233 | 4-5 | TRANSISTORS | | SS Ceramic | |
| SS Metal | | 2N5977 | | Pwr Metal | | 2N6234 | 4-5 | RF | | 2N6501 | 4-37 |
| 2N5763 | | 2N5978 | | 2N6077 | | 2N6235 | 4-5 | 2N6356 | | SS Metal | |
| OPTOS | | 2N5979 | | 2N6078 | | THYRISTORS | | 2N6357 | 4-53 | 2N6502 | |
| Photodetectors | | 2N5980 | | RF | | SCR | | 2N6358 | 4-53 | 2N6503 | |
| 2N5777 | 4-112 | 2N5981 | | 2N6080 | 4-54 | 2N6236 | 4-98 | 2N6370 | 4-57 | SS Plastic | |
| 2N5778 | 4-112 | 2N5982 | | 2N6081 | 4-55 | 2N6237 | 4-98 | Pwr Metal | | 2N6515 | 4-27 |
| 2N5779 | 4-112 | 2N5983 | | 2N6082 | 4-55 | 2N6238 | 4-98 | 2N6377 | 4-7 | 2N6516 | 4-27 |
| 2N5780 | 4-112 | 2N5984 | | 2N6083 | 4-55 | 2N6239 | 4-98 | 2N6378 | 4-7 | 2N6517 | 4-27 |
| TRANSISTORS | | 2N5985 | | 2N6084 | 4-55 | 2N6240 | 4-98 | 2N6379 | 4-7 | 2N6518 | 4-27 |
| SS Metal | | 2N5986 | 4-6 | 2N6094 | | 2N6241 | 4-98 | 2N6380 | | 2N6519 | 4-27 |
| 2N5793 | | 2N5987 | 4-6 | 2N6095 | | 2N6249 | 4-6 | 2N6381 | | 2N6520 | 4-27 |
| 2N5794 | | 2N5988 | 4-6 | 2N6096 | | 2N6250 | 4-5 | 2N6382 | | Dual Chip | |
| 2N5795 | 4-42 | 2N5989 | 4-6 | 2N6097 | | TRANSISTORS | | 2N6383 | 4-6 | 2N6521 | 4-45 |
| 2N5796 | 4-42 | 2N5990 | 4-6 | THYRISTORS | | RF | | 2N6384 | 4-6 | 2N6522 | 4-45 |
| Fet | | 2N5991 | 4-6 | PUT | | 2N6251 | 4-6 | 2N6385 | 4-6 | Pwr Metal | |
| 2N5797 | 4-31 | THYRISTORS | | 2N6116 | | 2N6255 | 4-54 | THYRISTORS | | 2N6542 | 4-5 |
| 2N5798 | 4-31 | PUT | | 2N6116JAN | | 2N6256 | 4-55 | SCR | | 2N6543 | 4-5 |
| 2N5799 | 4-31 | 2N6027 | | 2N6117JAN | | Pwr Metal | | 2N6394 | 4-98 | 2N6544 | 4-5 |
| 2N5800 | 4-31 | 2N6028 | | 2N6118 | | 2N6274 | 4-11 | 2N6395 | 4-98 | 2N6545 | 4-5 |
| RF | | TRANSISTORS | | 2N6118JAN | | 2N6275 | 4-7 | 2N6396 | 4-98 | 2N6546 | 4-6 |
| 2N5829 | 4-59 | Pwr Metal | | TRANSISTORS | | 2N6276 | 4-7 | 2N6397 | 4-98 | 2N6547 | 4-6 |
| 2N5835 | 4-60 | 2N6029 | 4-6 | RF | | 2N6277 | 4-7 | 2N6398 | 4-98 | Duowall | |
| 2N5836 | 4-60 | 2N6030 | 4-6 | 2N6136 | | 2N6278 | | 2N6399 | 4-98 | 2N6548 | 4-28 |
| 2N5837 | 4-60 | 2N6031 | 4-6 | THYRISTORS | | 2N6279 | | 2N6400 | 4-98 | 2N6549 | 4-28 |
| Pwr Metal | | Pwr Plastic | | Triac | | 2N6280 | | 2N6401 | 4-98 | 2N6551 | 4-28 |
| 2N5838 | | 2N6034 | 4-4 | 2N6145 | 4-102 | 2N6281 | | 2N6402 | 4-98 | 2N6552 | 4-28 |
| 2N5839 | | 2N6035 | 4-4 | 2N6146 | 4-102 | 2N6282 | 4-5 | 2N6403 | 4-98 | 2N6553 | 4-28 |
| 2N5840 | | 2N6036 | 4-4 | 2N6147 | 4-102 | 2N6283 | 4-5 | 2N6404 | 4-98 | 2N6554 | 4-28 |
| RF | | 2N6037 | 4-4 | 2N6151 | 4-99 | 2N6284 | 4-6 | 2N6405 | 4-98 | 2N6555 | 4-28 |
| 2N5841 | 4-60 | 2N6038 | 4-44 | 2N6152 | 4-99 | 2N6285 | 4-6 | TRANSISTORS | | 2N6556 | 4-28 |
| 2N5842 | | 2N6039 | 4-4 | 2N6153 | 4-99 | 2N6286 | 4-6 | Pwr Plastic | | 2N6557 | 4-28 |
| SS Plastic | | 2N6040 | 4-5 | 2N6154 | 4-99 | 2N6287 | 4-6 | 2N6406 | 4-3 | 2N6558 | 4-28 |
| 2N5845 | | 2N6041 | 4-5 | 2N6155 | 4-99 | 2N6294 | 4-7 | 2N6407 | 4-3 | 2N6559 | 4-28 |
| 2N5845A | | 2N6042 | 4-5 | 2N6156 | 4-99 | 2N6295 | 4-4 | 2N6408 | 4-3 | Pwr Metal | |
| RF | | 2N6043 | 4-5 | 2N6157 | 4-102 | 2N6296 | 4-7 | 2N6409 | 4-3 | 2N6569 | 4-6 |
| 2N5846 | 4-53 | 2N6044 | 4-5 | 2N6158 | 4-102 | 2N6297 | 4-4 | 2N6410 | 4-4 | 2N6576 | 4-6 |
| 2N5847 | 4-53 | 2N6045 | 4-5 | 2N6159 | 4-102 | 2N6298 | 4-5 | 2N6411 | 4-4 | 2N6577 | 4-6 |
| 2N5848 | 4-53 | Pwr Metal | | 2N6160 | 4-102 | 2N6299 | 4-5 | 2N6412 | 4-4 | 2N6580 | 4-6 |
| 2N5849 | 4-53 | 2N6049 | | 2N6161 | 4-102 | 2N6300 | 4-5 | 2N6413 | 4-4 | 2N6581 | 4-20 |
| SS Metal | | 2N6050 | 4-8 | 2N6162 | 4-102 | 2N6301 | 4-5 | 2N6414 | 4-4 | Fet | |
| 2N5859 | 4-15 | 2N6051 | 4-6 | 2N6163 | | RF | | 2N6415 | 4-4 | 3N124 | 4-33 |
| 2N5861 | 4-15 | 2N6052 | 4-6 | 2N6164 | | 2N6304 | 4-60 | 2N6416 | 4-4 | 3N125 | 4-33 |
| RF | | 2N6053 | 4-5 | 2N6165 | | 2N6305 | 4-60 | 2N6417 | 4-4 | 3N126 | 4-33 |
| 2N5862 | | 2N6054 | 4-5 | TRANSISTORS | | Pwr Metal | | 2N6418 | 4-4 | 3N128 | 4-33 |
| Pwr Metal | | 2N6055 | 4-5 | RF | | 2N6306 | 4-5 | 2N6419 | 4-4 | 3N140 | 4-33 |
| 2N5867 | | 2N6056 | 4-5 | 2N6166 | 4-58 | 2N6307 | 4-5 | 2N6420 | 4-3 | 3N155 | 4-32 |
| 2N5868 | | 2N6057 | 4-8 | THYRISTORS | | 2N6308 | 4-5 | 2N6421 | 4-3 | 3N155A | 4-32 |
| 2N5875 | 4-6 | 2N6058 | 4-6 | SCR | | 2N6312 | 4-5 | 2N6422 | 4-3 | 3N156 | 4-32 |
| 2N5876 | 4-6 | 2N6059 | 4-6 | 2N6167 | 4-100 | 2N6313 | 4-5 | 2N6423 | 4-3 | 3N157 | 4-32 |
| 2N5877 | 4-6 | THYRISTORS | | 2N6168 | 4-100 | 2N6314 | 4-5 | 2N6424 | 4-3 | 3N157A | 4-32 |
| 2N5878 | 4-6 | Triac | | 2N6169 | 4-100 | 2N6315 | | 2N6425 | 4-3 | 3N158 | 4-32 |
| 2N5879 | 4-6 | 2N6062 | 4-99 | 2N6170 | 4-100 | 2N6316 | | SS Plastic | | 3N169 | 4-32 |
| 2N5880 | 4-6 | 2N6063A | 4-99 | 2N6171 | 4-101 | 2N6317 | | 2N6426 | 4-45 | 3N170 | 4-32 |
| 2N5881 | 4-6 | 2N6063B | 4-99 | 2N6172 | 4-101 | 2N6318 | | 2N6427 | 4-45 | 3N171 | 4-32 |
| 2N5882 | 4-6 | 2N6063C | 4-99 | 2N6173 | 4-101 | 2N6319 | 4-7 | 2N6428 | | 3N209 | 4-33 |
| 2N5883 | 4-7 | 2N6063D | 4-99 | 2N6174 | 4-101 | 2N6320 | 4-7 | 2N6429 | | 3N210 | 4-33 |
| 2N5884 | 4-7 | 2N6063E | 4-99 | TRANSISTORS | | 2N6341 | 4-7 | 2N6430 | | 3N223 | 4-33 |
| 2N5885 | 4-7 | 2N6063F | 4-99 | Pwr Metal | | THYRISTORS | | 2N6431 | | 3N224 | 4-33 |
| 2N5886 | 4-7 | 2N6063G | 4-99 | 2N6186 | | Triac | | Pwr Metal | | | |
| | | 2N6063H | 4-99 | 2N6187 | | 2N6342 | 4-99 | 2N6436 | 4-7 | | |
| | | 2N6063I | 4-99 | 2N6188 | | 2N6342A | 4-99 | 2N6437 | 4-7 | | |
| | | 2N6063J | 4-99 | 2N6189 | | 2N6343 | 4-99 | 2N6438 | 4-7 | | |
| | | 2N6063K | 4-99 | 2N6190 | | 2N6343A | 4-99 | 2N6439 | 4-7 | | |

CATALOG INDEX (continued)

| DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE |
|-------------------------|-------|-------------------|-------|-----------------------------|-------|----------------|------|----------------|------|----------------|------|
| OPTOS | | MAC35-5 | 4-102 | DIODES | | MRTL | | MRTL | | mW MRTL | |
| Coupler | | MAC35-6 | 4-102 | Hot Carrier | | MC700 | 2-10 | MC794 | 2-10 | MC864 | 2-11 |
| 4N25 | 4-109 | MAC35-7 | 4-102 | MB0101 | 4-72 | MC701 | 2-10 | MC796 | 2-10 | MC867.A | 2-11 |
| 4N25A | 4-109 | MAC35-8 | 4-102 | MB0102 | 4-72 | MC702 | 2-10 | MC797 | 2-10 | MC870 | 2-11 |
| 4N26 | 4-109 | MAC35-10 | 4-102 | MB0103 | 4-72 | MC703 | 2-10 | | | | |
| 4N27 | 4-109 | MAC36-1 | 4-102 | MB0201 | 4-72 | MC704 | 2-10 | mW MRTL | | MRTL | |
| 4N28 | 4-109 | MAC36-2 | 4-102 | MB0301 | 4-72 | MC705 | 2-10 | MC798 | 2-11 | MC871 | |
| 4N29 | 4-109 | MAC36-3 | 4-102 | MB0501 | 4-72 | MC706 | 2-10 | | | MC874 | |
| 4N29A | 4-109 | MAC36-4 | 4-102 | MB0502 | 4-72 | MC707 | 2-10 | MRTL | | MC875 | |
| 4N30 | 4-109 | MAC36-5 | 4-102 | MB0701 | 4-72 | | | MC799 | 2-10 | | |
| 4N31 | 4-109 | MAC36-6 | 4-102 | MB0702 | 4-72 | mW MRTL | | MC800 | 2-10 | mW MRTL | |
| 4N32 | 4-109 | MAC36-7 | 4-102 | | | MC708 | 2-11 | MC801 | 2-10 | MC876 | 2-11 |
| 4N32A | 4-109 | MAC36-8 | 4-102 | VVC | | MC709 | 2-11 | MC802 | 2-10 | | |
| 4N33 | 4-109 | MAC36-10 | 4-102 | MB1101 | 4-72 | MC710 | 2-11 | MC803 | 2-10 | MRTL | |
| 4N35 | 4-109 | MAC37-1 | 4-102 | | | MC711 | 2-11 | MC804 | 2-10 | MC877 | |
| 4N36 | 4-109 | MAC37-2 | 4-102 | RECTIFIERS | | MC712 | 2-11 | MC805 | 2-10 | | |
| 4N37 | 4-109 | MAC37-3 | 4-102 | Schottky | | MC713 | 2-11 | MC806 | 2-10 | mW MRTL | |
| 4N38 | 4-109 | MAC37-4 | 4-102 | MBR320M | 4-92 | | | MC807 | 2-10 | MC878 | 2-11 |
| 4N38A | 4-109 | MAC37-5 | 4-102 | MBR330M | 4-92 | MRTL | | | | | |
| | | MAC37-6 | 4-102 | MBR335M | 4-92 | MC714 | 2-10 | mW MRTL | | MRTL | |
| DIODES | | MAC37-7 | 4-102 | MBR1520 | 4-92 | MC715 | 2-10 | MC808 | 2-11 | MC879 | |
| VVC | | MAC37-8 | 4-102 | MBR1530 | 4-92 | | | MC809 | 2-11 | MC880 | |
| BB105A | 4-70 | MAC37-10 | 4-102 | MBR1535 | 4-92 | mW MRTL | | MC810 | 2-11 | | |
| BB105AM | | MAC38-1 | 4-102 | MBR2520 | 4-92 | MC717 | 2-11 | MC811 | 2-11 | mW MRTL | |
| BB105B | 4-70 | MAC38-2 | 4-102 | MBR2530 | 4-92 | MC718 | 2-11 | MC812 | 2-11 | MC881 | 2-11 |
| BB105BM | | MAC38-3 | 4-102 | MBR2535 | 4-92 | MC719 | 2-11 | MC813 | 2-11 | MC882 | 2-11 |
| BB105G | 4-70 | MAC38-4 | 4-102 | MBR4020 | 4-92 | MC720 | 2-11 | | | | |
| BB105GM | | MAC38-5 | 4-102 | MBR4020PF | 4-92 | MC721 | 2-11 | MRTL | | MRTL | |
| | | MAC38-6 | 4-102 | MBR4030 | 4-92 | MC722 | 2-11 | MC814 | 2-10 | MC883 | 2-10 |
| TRANSISTORS | | MAC38-7 | 4-102 | MBR4030PF | 4-92 | | | MC815 | 2-10 | MC884 | 2-10 |
| RF | | MAC38-8 | 4-102 | MBR4035 | 4-92 | MRTL | | MC816 | 2-10 | MC885 | 2-10 |
| 8FR90 | 4-60 | MAC38-10 | 4-102 | | | MC723 | 2-10 | | | MC885.A | 2-10 |
| 8FR91 | 4-60 | MAC77-1 | 4-99 | THYRISTORS | | MC724.A | 2-10 | mW MRTL | | MC886 | 2-10 |
| 8FR92 | 4-60 | MAC77-2 | 4-99 | Bidirectional Switch | | MC725 | 2-10 | MC817 | 2-11 | MC887 | 2-10 |
| 8FXB9 | 4-60 | MAC77-3 | 4-99 | MBR4991 | 4-105 | MC726 | 2-10 | MC818 | 2-11 | MC888 | 2-10 |
| 8FY90 | 4-60 | MAC77-4 | 4-99 | MBR4992 | 4-105 | MC727 | 2-10 | MC819 | 2-11 | MC889.A | 2-10 |
| | | MAC77-5 | 4-99 | MIL-M-38510 | | | | MC820 | 2-11 | MC890 | 2-10 |
| Pwr Metal | | MAC77-6 | 4-99 | Devices | 5-5 | mW MRTL | | MC821 | 2-11 | MC891 | 2-10 |
| BUI08 | 4-5 | MAC77-7 | 4-99 | | | MC728 | 2-11 | MC822 | 2-11 | MC892 | 2-10 |
| BUI26 | | MAC77-8 | 4-99 | LINEAR | | | | | | | |
| BUI205 | 4-4 | MAC92-1 | 4-99 | MC8113L | 3-6 | MRTL | | MRTL | | mW MRTL | |
| BUI208 | 4-9 | MAC92-2 | 4-99 | MC8113P | 3-6 | MC729 | 2-10 | MC824.A | 2-10 | MC893 | 2-11 |
| BYW60 | 4-89 | MAC92-3 | 4-99 | MC8114L | 3-6 | | | MC825 | 2-10 | | |
| BYW61 | 4-89 | MAC92-4 | 4-99 | MC8114P | 3-6 | mW MRTL | | MC826 | 2-10 | MRTL | |
| BYW62 | 4-89 | MAC92-5 | 4-99 | MC8123L | 3-6 | MC764 | 2-11 | MC827 | 2-10 | MC894 | 2-10 |
| BYW64 | 4-89 | MAC92-6 | 4-99 | MC8123P | 3-6 | MC767.A | 2-11 | | | MC896 | 2-10 |
| BYW66 | 4-89 | MAC92A-1 | 4-99 | MC8124L | 3-6 | MC770 | 2-11 | mW MRTL | | MC897 | 2-10 |
| BYW68 | 4-89 | MAC92A-2 | 4-99 | MC8124P | 3-6 | | | MC828F | 2-11 | | |
| | | MAC92A-3 | 4-99 | MC8126 | 3-7 | MRTL | | | | mW MRTL | |
| MICROCOMPUTER | | MAC92A-4 | 4-99 | MRTL | | MC771 | 2-10 | MRTL | | MC898 | 2-11 |
| Family | | MAC92A-5 | 4-99 | MC660 | | MC774 | 2-10 | MC829 | 2-10 | | |
| M6800 | 1-2 | MAC92A-6 | 4-99 | MC661 | | MC775 | 2-10 | | | MRTL | |
| | | MAC220-2 | 4-99 | MC662 | | | | MDTL | | MC899 | |
| Support Hardware | | MAC220-3 | 4-99 | MC663 | | mW MRTL | | MC830 | 2-8 | MC900 | 2-10 |
| M6800 | 1-4 | MAC220-7 | 4-99 | MC664 | | 2N776 | 2-11 | MC831 | 2-8 | MC901 | 2-10 |
| | | MAC220-9 | 4-99 | MC665 | | MRTL | | MC832 | 2-8 | MC902 | 2-10 |
| Support Software | | MAC221-2 | 4-99 | MC666 | | MC777 | 2-10 | MC833 | 2-8 | MC903 | 2-10 |
| M6800 | 1-4 | MAC221-3 | 4-99 | MC667 | | | | MC834 | 2-8 | MC904 | 2-10 |
| | | MAC221-5 | 4-99 | MC668 | | mW MRTL | | MC835 | 2-8 | MC905 | 2-10 |
| System Support | | MAC221-7 | 4-99 | MC669 | | MC778 | 2-11 | MC836 | 2-8 | MC906 | 2-10 |
| M6800 | 1-3 | MAC221-9 | 4-99 | MC670 | | | | MC837 | 2-8 | MC907 | 2-10 |
| | | MAC4688 | 4-103 | MC671 | | MRTL | | MC838 | 2-8 | | |
| THYRISTORS | | MAC4689 | 4-103 | MC672 | | MC779 | 2-10 | MC839 | 2-8 | mW MRTL | |
| Triac | | MAC4690 | 4-103 | MC673 | | MC780 | 2-10 | MC840 | 2-8 | MC908 | 2-11 |
| MAC10-1 | 4-99 | MAC5441 | 4-103 | MC674 | | | | MC841 | 2-8 | MC909 | 2-11 |
| MAC10-2 | 4-99 | MAC5442 | 4-103 | MC675 | | mW MRTL | | MC843 | 2-8 | MC910 | 2-11 |
| MAC10-3 | 4-99 | MAC5443 | 4-103 | MC676 | | MC781 | 2-11 | MC844 | 2-8 | MC911 | 2-11 |
| MAC10-4 | 4-99 | MAC5444 | 4-103 | MC677 | | MC782 | 2-11 | MC845 | 2-8 | MC912 | 2-11 |
| MAC10-5 | 4-99 | MAC5445 | 4-103 | MC678 | | | | MC846 | 2-8 | MC913 | 2-11 |
| MAC10-6 | 4-99 | MAC5446 | 4-103 | MC679 | | MRTL | | MC847 | 2-8 | | |
| MAC10-7 | 4-99 | MAC6400-80 | 4-103 | MC680 | | MC783 | 2-10 | MC848 | 2-8 | MRTL | |
| MAC10-8 | 4-99 | MAC6410-80 | 4-103 | MC681 | | MC784 | 2-10 | MC849 | 2-8 | MC914 | 2-10 |
| MAC11-1 | 4-99 | MAC6420-80 | 4-103 | MC682 | | MC785.A | 2-10 | MC850 | 2-9 | MC915 | 2-10 |
| MAC11-2 | 4-99 | MAC40688 | 4-103 | MC683 | | MC786 | 2-10 | MC851 | 2-9 | MC916 | 2-10 |
| MAC11-3 | 4-99 | MAC40689 | 4-103 | MC684 | | MC787 | 2-10 | MC852 | 2-9 | | |
| MAC11-4 | 4-99 | MAC40690 | 4-103 | MC685 | | MC788 | 2-10 | MC853 | 2-9 | mW MRTL | |
| MAC11-5 | 4-99 | MAC40795 | 4-102 | MC686 | | MC789.A | 2-10 | MC855 | 2-9 | MC917 | 2-11 |
| MAC11-6 | 4-99 | MAC40796 | 4-102 | MC688 | | MC790 | 2-10 | MC856 | 2-9 | MC918 | 2-11 |
| MAC11-7 | 4-99 | MAC40797 | 4-102 | MC689 | | MC791 | 2-10 | MC857 | 2-9 | MC919 | 2-11 |
| MAC11-8 | 4-99 | MAC40798 | 4-102 | MC690 | | MC792 | 2-10 | MC858 | 2-9 | MC920 | 2-11 |
| MAC35-1 | 4-102 | MAC40799 | 4-102 | MC691 | | | | MC861 | 2-9 | MC921 | 2-11 |
| MAC35-2 | 4-102 | MAC40800 | 4-102 | MC696 | | mW MRTL | | MC862 | 2-9 | MC922 | 2-11 |
| MAC35-3 | 4-102 | MAC40801 | 4-102 | MC699 | | MC793 | 2-11 | MC863 | 2-9 | | |
| MAC35-4 | 4-102 | | | | | | | | | | |

CATALOG INDEX (continued)

| DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE |
|---------|------|----------|------|----------|------|--------|------|---------|------|--------|------|
| MRTL | | MC1310 | 3-33 | MC1535 | 4-16 | MC1803 | 2-9 | MC3108 | | MC4017 | 2-6 |
| MC924 | 2-10 | MC1311 | 3-33 | MC1536 | 3-15 | MC1804 | 2-9 | MC3109 | | MC4018 | 2-6 |
| MC925 | 2-10 | MC1312 | 3-33 | MC1537 | 3-16 | MC1805 | 2-9 | MC3110 | | MC4019 | 2-6 |
| MC926 | 2-10 | MC1314 | 3-33 | MC1538 | 3-15 | MC1806 | 2-9 | MC3111 | | MC4021 | |
| MC927 | 2-10 | MC1315 | 3-33 | MC1539 | 3-14 | MC1807 | 2-9 | MC3112 | | MC4022 | |
| mW MRTL | | MC1323 | 3-22 | MC1540 | | MC1808 | 2-9 | MC3115 | | MC4023 | |
| MC928 | 2-11 | MC1324 | 3-22 | MC1541 | | MC1809 | 2-9 | MC3116 | | MC4024 | 2-6 |
| | | MC1326 | 3-22 | MC1543 | | MC1810 | 2-9 | MC3118 | | MC4027 | |
| | | MC1327 | 3-22 | MC1544 | 3-5 | MC1811 | 2-9 | MC3119 | | MC4028 | |
| MRTL | | MC1328 | 3-22 | MC1545 | 3-17 | MC1812 | 2-9 | MC3120 | | MC4029 | |
| MC929 | 2-10 | MC1329 | 3-22 | MC1550 | 3-17 | MC1813 | 2-9 | MC3121 | | MC4030 | |
| | | MC1330 | 3-22 | MC1552 | 3-18 | MC1814 | 2-9 | MC3122 | | MC4031 | |
| MDTL | | MC1331 | 3-22 | MC1553 | 3-18 | MC1815 | 2-9 | MC3123 | | MC4032 | |
| MC930 | 2-8 | MC1344 | 3-22 | MC1554 | 3-21 | MC1816 | 2-9 | MC3124 | | MC4035 | |
| MC931 | 2-8 | MC1349 | 3-22 | MC1555 | 3-21 | MC1818 | 2-9 | MC3125 | | MC4037 | |
| MC932 | 2-8 | MC1350 | 3-22 | MC1556 | 3-15 | MC1820 | 2-9 | MC3126 | | MC4038 | |
| MC933 | 2-8 | MC1351 | 3-22 | MC1558 | 3-16 | MC1900 | 2-9 | MC3128 | | MC4040 | |
| MC934 | 2-8 | MC1352 | 3-22 | MC1560 | | MC1901 | 2-9 | MC3129 | | MC4041 | |
| MC935 | 2-8 | MC1353 | 3-22 | MC1561 | | MC1902 | 2-9 | MC3130 | | MC4042 | |
| MC936 | 2-8 | MC1355 | 3-23 | MC1563 | | MC1903 | 2-9 | MC3131 | | MC4043 | |
| MC937 | 2-8 | MC1358 | 3-23 | MC1566 | | MC1904 | 2-9 | MC3132 | | MC4044 | 2-6 |
| MC938 | 2-8 | MC1357 | 3-23 | MC1568 | | MC1905 | 2-9 | MC3133 | | MC4048 | |
| MC939 | 2-8 | MC1358 | 3-23 | MC1569 | | MC1906 | 2-9 | MC3134 | | MC4050 | |
| MC940 | 2-8 | MC1364 | 3-23 | MC1585 | | MC1907 | 2-9 | MC3150 | | MC4051 | |
| MC941 | 2-8 | MC1370 | 3-23 | MC1590 | 3-17 | MC1908 | 2-9 | MC3151 | | MC4062 | |
| MC943 | 2-8 | MC1371 | 3-23 | MC1594 | 3-21 | MC1909 | 2-9 | MC3152 | | MC4300 | |
| MC944 | 2-8 | MC1375 | 3-23 | MC1595 | 3-21 | MC1910 | 2-9 | MC3153 | | MC4304 | |
| MC945 | 2-8 | MC1385 | 3-23 | MC1596 | 3-21 | MC1911 | 2-9 | MC3154 | | MC4305 | |
| MC946 | 2-8 | MC1391 | 3-23 | MECL | | MC1912 | 2-9 | MC3155 | | MC4306 | |
| MC947 | 2-8 | MC1394 | 3-23 | MC1601 | 2-4 | MC1914 | 2-9 | MC3160 | | MC4307 | |
| MC948 | 2-8 | MC1398 | 3-23 | MC1602 | 2-4 | MC1915 | 2-9 | MC3161 | | MC4308 | |
| MC949 | 2-8 | MC1405 | 3-9 | MC1603 | 2-4 | MC1916 | 2-9 | MC3162 | | MC4310 | |
| MC950 | 2-9 | MC1406 | 3-9 | MC1604 | 2-4 | MC1918 | 2-9 | MC3163 | | MC4315 | 2-6 |
| MC951 | 2-9 | MC1407 | 3-9 | MC1605 | 2-4 | | | | | MC4317 | 2-6 |
| MC952 | 2-9 | MC1408L6 | 3-9 | MC1648 | 2-4 | MTTL | | LINEAR | | MC4318 | 2-6 |
| MC953 | 2-9 | MC1408L7 | 3-9 | MC1650 | 2-4 | MC3000 | | MC3301 | 3-24 | MC4319 | 2-6 |
| MC955 | 2-9 | MC1408L8 | 3-9 | MC1651 | 2-4 | MC3001 | | MC3302 | 3-24 | MC4324 | 2-6 |
| MC956 | 2-9 | MC1410 | 3-18 | MC1654 | 2-4 | MC3002 | | MC3303 | 3-16 | MC4325 | |
| MC957 | 2-9 | MC1414 | 3-13 | MC1658 | 2-4 | MC3003 | | MC3310P | 3-23 | MC4327 | |
| MC958 | 2-9 | MC1420 | 3-14 | MC1660 | 2-4 | MC3004 | | MC3330 | | MC4328 | |
| MC961 | 2-9 | MC1430 | 3-16 | MC1662 | 2-4 | MC3005 | | MC3340P | 3-24 | MC4329 | |
| MC962 | 2-9 | MC1431 | 3-16 | MC1664 | 2-4 | MC3006 | | MC3360P | 3-23 | MC4330 | |
| MC963 | 2-9 | MC1433 | 3-16 | MC1666 | 2-4 | MC3007 | | MC3370 | | MC4331 | |
| | | MC1435 | 3-16 | MC1668 | 2-4 | MC3008 | | MC3380 | | MC4332 | |
| MRTL | | MC1436 | 3-15 | MC1670 | 2-4 | MC3009 | | MC3401 | 3-16 | MC4335 | |
| MC971 | 2-10 | MC1436C | 3-15 | MC1672 | 2-4 | MC3010 | | MC3403 | 3-16 | MC4337 | |
| MC974 | 2-10 | MC1437 | 3-16 | MC1674 | 2-4 | MC3011 | | MC3416 | 3-10 | MC4344 | 2-6 |
| MC975 | 2-10 | MC1438 | | MC1678 | 2-4 | MC3012 | | MC3430 | 3-12 | MC4350 | |
| | | MC1439 | | MC1688 | 2-4 | MC3015 | | MC3431 | 3-12 | MC4500 | |
| mW MRTL | | MC1441 | | MC1690 | 2-4 | MC3016 | | MC3432 | 3-12 | MC4501 | |
| MC976 | 2-11 | MC1444 | 3-5 | MC1692 | 2-4 | MC3018 | | MC3433 | 3-12 | MC4502 | |
| MC978 | 2-11 | MC1445 | 3-17 | MC1694 | 2-4 | MC3019 | | MC3437 | 3-6 | MC4503 | |
| MC981 | 2-11 | MC1446L | | MC1696 | 2-4 | MC3020 | | MC3438 | 3-6 | MC4504 | |
| MC982 | 2-11 | MC1454 | 3-21 | MC1699 | 2-4 | MC3021 | | MC3440 | 3-7 | MC4505 | |
| | | MC1455 | 3-21 | | | MC3022 | | MC3441 | 3-7 | MC4506 | |
| MRTL | | MC1456 | 3-15 | LINEAR | | MC3023 | | MC3443 | 3-7 | MC4507 | |
| MC983 | 2-10 | MC1456C | 3-15 | MC1709 | 3-14 | MC3024 | | MC3450 | 3-11 | MC4508 | |
| MC984 | 2-10 | MC1458 | 3-15 | MC1709A | 3-14 | MC3025 | | MC3452 | 3-11 | MC4509 | |
| MC985 | 2-10 | MC1458C | 3-15 | MC1709C | 3-14 | MC3026 | | MC3453 | 3-11 | MC4510 | |
| MC986 | 2-10 | MC1460 | | MC1710 | 3-12 | MC3028 | | MC3456 | 3-21 | MC4516 | |
| MC988 | 2-10 | MC1461 | | MC1710C | 3-12 | MC3029 | | MC3459 | 3-4 | MC4517 | |
| MC989 | 2-10 | MC1463 | | MC1711 | 3-12 | MC3030 | | MC3460 | 3-4 | MC4520 | |
| MC990 | 2-10 | MC1465 | | MC1711C | 3-12 | MC3031 | | MC3461 | 3-3 | MC4526 | |
| MC991 | 2-10 | MC1468 | | MC1712 | 3-16 | MC3032 | | MC3466 | 3-4 | MC4530 | |
| MC992 | 2-10 | MC1469 | | MC1712C | 3-16 | MC3033 | | MC3476 | 3-15 | MC4537 | |
| | | MC1488 | 3-10 | MC1723 | | MC3034 | | MC3490 | 3-8 | MC4538 | |
| mW MRTL | | MC1488L | 3-10 | MC1723C | | MC3050 | | MC3491 | 3-8 | MC4540 | |
| MC993 | 2-11 | MC1489 | 3-10 | MC1733 | 3-18 | MC3051 | | MC3494 | 3-8 | MC4542 | |
| | | MC1489A | 3-10 | MC1733C | 3-18 | MC3052 | | MC3503 | 3-16 | MC4543 | |
| MRTL | | MC1494 | 3-21 | MC1741 | 3-15 | MC3053 | | MC3556 | 3-21 | MC4544 | |
| MC996 | 2-10 | MC1495 | 3-21 | MC1741C | 3-15 | MC3054 | | | | MC4545 | |
| MC997 | 2-10 | MC1496 | 3-21 | MC1741SC | 3-15 | MC3055 | | MTTL | | MC4546 | |
| | | MC1505 | 3-9 | MC1747 | 3-16 | MC3060 | | MC4000 | | MC4547 | |
| mW MRTL | | MC1506 | 3-9 | MC1747C | 3-16 | MC3061 | | MC4001 | | MC4548 | |
| MC998 | 2-11 | MC1507 | 3-9 | MC1748 | 3-14 | MC3062 | | MC4002 | | MC4549 | |
| | | MC1508 | | MC1748C | 3-14 | MC3063 | | MC4004 | | MC4550 | |
| MRTL | | MC1508L8 | 3-9 | MC1776 | 3-15 | MC3100 | | MC4005 | | MC4551 | |
| MC999 | 2-10 | MC1510 | 3-18 | MC1776C | 3-15 | MC3101 | | MC4006 | | MC4553 | |
| LINEAR | | MC1514 | 3-13 | | | MC3102 | | MC4007 | | MC4554 | |
| MC1303 | 3-33 | MC1520 | 3-14 | MDTL | | MC3103 | | MC4008 | | MC4560 | |
| MC1304 | 3-33 | MC1530 | 4-16 | MC1800 | 2-9 | MC3104 | | MC4010 | | MC4570 | |
| MC1305 | 3-33 | MC1531 | 4-16 | MC1801 | 2-9 | MC3105 | | MC4012 | | MC4572 | |
| MC1306 | 3-33 | MC1533 | 4-16 | MC1802 | 2-9 | MC3106 | | MC4015 | | MC4573 | |
| MC1307 | 3-33 | | | | | MC3107 | | MC4016 | 2-6 | MC4575 | |

CATALOG INDEX (continued)

| DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE |
|----------|------|---------|------|-----------|------|--------|------|---------|------|---------|------|
| MC5477 | | MC7266 | | MC74H71 | | MC8322 | | mW MRTL | | MC10158 | 2-3 |
| MC5479 | | MC7267 | | MC74H72 | | MC8324 | | MC9718 | 2-11 | MC10170 | 2-3 |
| MC5480 | | MC7270 | | MC74H73 | | MC8328 | | | | MC10171 | 2-3 |
| MC5483 | | MC7271 | | MC74H74A | | MC8300 | | MRTL | | MC10172 | 2-3 |
| MC5484 | | MC7280 | | MC74H79 | | MC8301 | | MC9719A | | MC10173 | 2-3 |
| MC5486 | | MC7281 | | MC74H86 | | MC8304 | | | | MC10174 | 2-3 |
| MC5490 | | MC7400 | | MC74H89 | | MC8306 | | | | MC10175 | 2-3 |
| MC5491A | | MC7401 | | MC74H115 | | MC8307 | | mW MRTL | | MC10176 | 2-3 |
| MC5492 | | MC7402 | | MC74H116 | | MC8308 | | MC9720 | 2-11 | MC10177 | 2-3 |
| MC5493 | | MC7404 | | MC74H117 | | MC8309 | | MC9721 | 2-11 | MC10178 | 2-3 |
| MC5494 | | MC7405 | | MC74H118 | | MC8310 | | MC9722 | 2-11 | MC10179 | 2-3 |
| MC5495 | | MC7406 | | MC74H119 | | MC8311 | | MC9723 | 2-11 | MC10180 | 2-3 |
| MC5496 | | MC7407 | | MC74H120 | | MC8312 | | MC9724 | 2-11 | MC10181 | 2-3 |
| MC54H00 | | MC7408 | | | | MC8314 | | MC9725 | 2-11 | MC10182 | 2-3 |
| MC54H01 | | MC7409 | | LINEAR | | MC8316 | | | | MC10183 | 2-3 |
| MC54H02 | | MC7410 | | MC7522 | 3-5 | MC8318 | | MRTL | | MC10186 | 2-3 |
| MC54H04 | | MC7416 | | MC7523 | 3-5 | MC8322 | | MC9801 | 2-10 | MC10190 | 2-3 |
| MC54H05 | | MC7417 | | MC7524 | 3-5 | MC8324 | | MC9802 | 2-10 | MC10191 | 2-3 |
| MC54H08 | | MC7420 | | MC7525 | 3-5 | MC8328 | | MC9804 | 2-10 | MC10193 | 2-3 |
| MC54H10 | | MC7426 | | MC7528 | 3-5 | MC8375 | | MC9807 | 2-10 | MC10194 | 2-3 |
| MC54H11 | | MC7430 | | MC7529 | 3-5 | MC8377 | | MC9809 | 2-10 | MC10195 | 2-3 |
| MC54H12 | | MC7437 | | MC7534 | 3-5 | MC8383 | | MC9813 | 2-10 | MC10197 | 2-3 |
| MC54H20 | | MC7438 | | MC7535 | 3-5 | | | MC9814 | 2-10 | MC10210 | 2-3 |
| MC54H21 | | MC7440 | | MC7538 | 3-5 | LSI | | MC9815 | 2-10 | MC10211 | 2-3 |
| MC54H22 | | MC7441A | | MC7539 | 3-5 | MC8500 | 2-5 | | | MC10212 | 2-3 |
| MC54H28 | | MC7442 | | MC7705C | 3-19 | MC8501 | 2-5 | mW MRTL | | MC10216 | 2-3 |
| MC54H29 | | MC7443 | | MC7706C | 3-19 | MC8502 | 2-5 | MC9818 | 2-11 | MC10231 | 2-3 |
| MC54H30 | | MC7444 | | MC7708C | 3-19 | MC8503 | 2-5 | | | MC10287 | 2-3 |
| MC54H31 | | MC7445 | | MC7712C | 3-19 | MC8504 | 2-5 | MRTL | | MC10501 | 2-2 |
| MC54H32 | | MC7446 | | MC7715C | 3-19 | MC8505 | 2-5 | MC9819A | 2-10 | MC10502 | 2-2 |
| MC54H36 | | MC7447 | | MC7718C | 3-19 | MC8506 | 2-5 | | | MC10504 | 2-2 |
| MC54H39 | | MC7448 | | MC7720C | 3-19 | MC8520 | 2-5 | mW MRTL | | MC10505 | 2-2 |
| MC54H40 | | MC7449 | | MC7724C | 3-19 | MC8521 | 2-5 | MC9820 | 2-11 | MC10506 | 2-2 |
| MC54H50 | | MC7450 | | MC7805C | 3-19 | MC8522 | 2-5 | MC9821 | 2-11 | MC10507 | 2-2 |
| MC54H51 | | MC7451 | | MC7806C | 3-19 | MC8523 | 2-5 | MC9822 | 2-11 | MC10509 | 2-2 |
| MC54H52 | | MC7453 | | MC7808C | 3-19 | MC8524 | 2-5 | MC9823 | 2-11 | MC10514 | 2-2 |
| MC54H53 | | MC7454 | | MC7812C | 3-19 | | | MC9824 | 2-11 | MC10515 | 2-2 |
| MC54H54 | | MC7460 | | MC7815C | 3-19 | MTTL | | MC9825 | 2-11 | MC10516 | 2-2 |
| MC54H55 | | MC7470 | | MC7818C | 3-19 | MC8601 | | | | MC10517 | 2-2 |
| MC54H60 | | MC7472 | | MC7824C | 3-19 | MC8602 | | MECL | | MC10518 | 2-2 |
| MC54H61 | | MC7473 | | MC7902C | 3-19 | MC8603 | | MC10100 | 2-2 | MC10519 | 2-2 |
| MC54H62 | | MC7475 | | MC7905C | 3-19 | | | MC10101 | 2-2 | MC10521 | 2-2 |
| MC54H71 | | MC7476 | | MC7905.2C | 3-19 | LINEAR | | MC10102 | 2-2 | MC10524 | 2-2 |
| MC54H72 | | MC7477 | | MC7906C | 3-19 | MC8713 | | MC10103 | 2-2 | MC10525 | 2-2 |
| MC54H73 | | MC7479 | | MC7908C | 3-19 | MC8714 | | MC10104 | 2-2 | MC10530 | 2-2 |
| MC54H74A | | MC7480 | | MC7912C | 3-19 | MC8723 | | MC10105 | 2-2 | MC10531 | 2-2 |
| MC54H79 | | MC7483 | | MC7915C | 3-19 | MC8724 | | MC10106 | 2-2 | MC10533 | 2-2 |
| MC54H86 | | MC7484 | | MC7918C | 3-19 | MC8726 | | MC10107 | 2-2 | MC10535 | 2-2 |
| MC54H89 | | MC7486 | | MC7924C | 3-19 | | | MC10109 | 2-2 | MC10536 | 2-2 |
| MC54H115 | | MC7490 | | MC78M05 | 3-19 | MTTL | | MC10110 | 2-2 | MC10537 | 2-3 |
| MC54H116 | | MC7491A | | MC78M06 | 3-19 | MC9300 | | MC10111 | 2-2 | MC10541 | 2-3 |
| MC54H117 | | MC7492 | | MC78M08 | 3-19 | MC9301 | | MC10113 | 2-2 | MC10560 | 2-3 |
| MC54H118 | | MC7493 | | MC78M12 | 3-19 | MC9304 | | MC10114 | 2-2 | MC10561 | 2-3 |
| MC54H119 | | MC7495 | | MC78M15 | 3-19 | MC9306 | | MC10115 | 2-2 | MC10562 | 2-3 |
| MC54H120 | | MC7496 | | MC78M18 | 3-19 | MC9307 | | MC10116 | 2-2 | MC10564 | 2-3 |
| | | MC74H00 | | MC78M20 | 3-19 | MC9308 | | MC10117 | 2-2 | MC10571 | 2-3 |
| | | MC74H01 | | MC78M24 | 3-19 | MC9309 | | MC10118 | 2-2 | MC10572 | 2-3 |
| LINEAR | | | | | | MC9310 | | MC10119 | 2-2 | MC10574 | 2-3 |
| MC5522 | 3-5 | MC74H02 | | MTTL | | MC9311 | | MC10121 | 2-2 | MC10575 | 2-3 |
| MC5523 | 3-5 | MC74H04 | | MC8241 | | MC9312 | | MC10123 | 2-2 | MC10576 | 2-3 |
| MC5524 | 3-5 | MC74H05 | | MC8242 | | MC9314 | | MC10124 | 2-2 | MC10580 | 2-3 |
| MC5525 | 3-5 | MC74H08 | | MC8250 | | MC9316 | | MC10125 | 2-2 | MC10581 | 2-3 |
| MC5528 | 3-5 | MC74H10 | | MC8251 | | MC9318 | | MC10128 | 2-2 | MC10616 | 2-3 |
| MC5529 | 3-5 | MC74H11 | | MC8260 | | MC9322 | | MC10129 | 2-2 | MC10631 | 2-3 |
| MC5534 | 3-5 | MC74H12 | | MC8261 | | MC9324 | | MC10130 | 2-2 | | |
| MC5535 | 3-5 | MC74H20 | | MC8266 | | MC9328 | | MC10131 | 2-2 | PLL | |
| MC5538 | 3-5 | MC74H21 | | MC8267 | | MC9375 | | MC10132 | 2-2 | MC12000 | 2-6 |
| MC5539 | 3-5 | MC74H28 | | MC8270 | | MC9377 | | MC10133 | 2-2 | MC12012 | 2-6 |
| | | MC74H29 | | MC8271 | | MC9383 | | MC10134 | 2-2 | MC12013 | 2-6 |
| MOS | | MC74H30 | | MC8280 | | MC9601 | | MC10135 | 2-2 | MC12014 | 2-6 |
| MC6800 | | MC74H31 | | MC8281 | | MC9602 | | MC10136 | 2-2 | MC12020 | 2-6 |
| MC6802 | | MC74H32 | | MC8300 | | MC9603 | | MC10137 | 2-2 | MC12021 | 2-6 |
| MC6850 | | MC74H36 | | MC8301 | | | | MC10138 | 2-3 | MC12040 | 2-6 |
| MC6852 | | MC74H39 | | MC8304 | | MRTL | | MC10141 | 2-3 | MC12060 | 2-6 |
| MC6860 | | MC74H40 | | MC8306 | | MC9701 | 2-10 | MC10143 | 2-3 | MC12061 | 2-6 |
| MC6862 | | MC74H51 | | MC8307 | | MC9702 | 2-10 | MC10158 | 2-3 | MC12513 | 2-6 |
| MC6863 | | MC74H52 | | MC8308 | | MC9704 | 2-10 | MC10159 | 2-3 | MC12520 | 2-6 |
| | | MC74H53 | | MC8309 | | MC9707 | 2-10 | MC10160 | 2-3 | MC12521 | 2-6 |
| MTTL | | MC74H54 | | MC8310 | | MC9709 | 2-10 | MC10161 | 2-3 | MC12540 | 2-6 |
| MC7241 | | MC74H55 | | MC8311 | | MC9713 | 2-10 | MC10162 | 2-3 | MC12560 | 2-6 |
| MC7242 | | MC74H60 | | MC8312 | | MC9714 | 2-10 | MC10163 | 2-3 | MC12561 | 2-6 |
| MC7250 | | MC74H61 | | MC8314 | | MC9715 | 2-10 | MC10164 | 2-3 | | |
| MC7251 | | MC74H62 | | MC8316 | | | | MC10165 | 2-3 | LINEAR | |
| MC7260 | | | | MC8318 | | | | MC10166 | 2-3 | MC13120 | |

CATALOG INDEX (continued)

| DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE |
|-------------|------|----------|------|-----------|------|-----------|------|------------------|------|-------------|-------|
| MOS | | MC14554 | 1-7 | MC74416 | 2-6 | MCA2214 | 4-81 | MC1936 | 2-14 | MC5004AL1 | 2-15 |
| MC14000 | 1-7 | MC14555 | 1-7 | MC74417 | 2-6 | MC2221 | 4-81 | MC1944 | 2-14 | MC5033AL1 | 2-15 |
| MC14001 | 1-7 | MC14556 | 1-7 | MC74418 | 2-6 | MC2222 | 4-81 | MC1945 | 2-14 | MC5304AL1 | 2-15 |
| MC14002 | 1-7 | MC14557 | 1-7 | MC74419 | 2-6 | MC2223 | 4-81 | MC1946 | 2-14 | | |
| MC14006 | 3-7 | MC14558 | 1-7 | MC74450 | | MC2224 | 4-81 | MC1948 | 2-14 | MOS | |
| MC14007 | 1-7 | MC14559 | 1-7 | MC74452 | | MC2231 | 4-81 | MC1962 | 2-14 | MC6550 | 1-6 |
| MC14008 | 1-7 | MC14560 | 1-7 | MC74453 | | MC2232 | 4-81 | MC194H00 | 2-13 | MC6560 | 1-6 |
| MC14011 | 1-7 | MC14561 | 1-7 | MC74454 | | MC2233 | 4-81 | MC194H01 | 2-13 | MC6561 | 1-6 |
| MC14012 | 1-7 | MC14562 | 1-7 | MC74455 | | MC2234 | 4-81 | MC194H04 | 2-13 | MC6562 | 3-6 |
| MC14013 | 1-7 | MC14566 | 1-7 | MC74456 | | | | MC194H10 | 2-13 | MC6570 | 1-6 |
| MC14014 | 1-7 | MC14572 | 1-7 | MC74460 | | LINEAR | | MC194H20 | 2-13 | MC6571A | 3-6 |
| MC14015 | 1-7 | MC14580 | 1-7 | MC74468 | | MCB1709 | 3-14 | MC194H31 | 2-13 | MC6572 | 1-6 |
| MC14016 | 1-7 | MC14581 | 1-7 | | | MCB1710 | | MC194H40 | 2-13 | MC6573 | 3-6 |
| MC14017 | 1-7 | MC14582 | 1-7 | LINEAR | | MCB1723 | | MC194H51 | 2-13 | MC6574 | 1-6 |
| MC14020 | 1-7 | MC14583 | 1-7 | MC75107 | 3-10 | MCB1741 | | MC194H54 | 2-13 | MC6575 | 1-6 |
| MC14021 | 1-7 | MC14585 | 1-7 | MC75108 | 3-10 | MCB1748 | | MC194H56 | 2-13 | MC6576 | 1-6 |
| MC14022 | 1-7 | | | MC75109 | 3-10 | MCBC1709 | 3-14 | MC194H57 | 2-13 | MC6577 | 3-6 |
| MC14023 | 1-7 | MTTL | | MC75110 | 3-10 | MCBC1710 | | MC194H72 | 2-13 | MC6578 | 1-6 |
| MC14024 | 1-7 | MC15482 | | MC75140 | | MCBC1723 | | MC194H73 | 2-13 | MC6579 | 1-6 |
| MC14025 | 1-7 | MC17482 | | MC75325 | 3-5 | MCBC1741 | 3-15 | MC194H79 | 2-13 | MC6580 | 1-6 |
| MC14027 | 1-7 | MC25482 | | MC75358 | 3-3 | MCBC1748 | 3-14 | MC194H146 | 2-13 | MC6581 | 3-6 |
| MC14028 | 1-7 | MC27482 | | MC75365 | 3-4 | | | MC194H103 | 2-13 | MC6583 | 1-6 |
| MC14032 | 1-7 | MC54100 | | MC75368 | 3-3 | MTTL | | MC194H54 | 2-13 | MC6590 | 1-6 |
| MC14034 | 1-7 | MC54107 | | MC75450 | 3-11 | MCBC5400 | 2-12 | MC194H56 | 2-13 | MC6591 | 3-6 |
| MC14035 | 1-7 | MC54121 | | MC75451 | 3-11 | MCBC5401 | 2-12 | MC194H57 | 2-13 | MC6604 | 1-5 |
| MC14038 | 1-7 | MC54145 | | MC75452 | 3-11 | MCBC5402 | 2-12 | MC194H57 | 2-13 | MC6604-2 | 1-5 |
| MC14040 | 1-7 | MC54150 | | MC75453 | 3-11 | MCBC5404 | 2-12 | MC194H00 | 2-13 | MC6604-4 | 1-5 |
| MC14042 | 1-7 | MC54151 | | MC75454 | 3-11 | MCBC5405 | 2-12 | MC194H01 | 2-13 | MC6605A | 1-5 |
| MC14046 | 1-7 | MC54152 | | MC75461 | 3-11 | MCBC5410 | 2-12 | MC194H04 | 2-13 | MC6605A1 | 1-5 |
| MC14049 | 1-7 | MC54153 | | MC75462 | 3-11 | MCBC5420 | 2-12 | MC194H10 | 2-13 | MC6605A2 | 1-5 |
| MC14050 | 1-7 | MC54155 | | MC75463 | 3-11 | MCBC5430 | 2-12 | MC194H20 | 2-13 | MC6616 | 1-5 |
| MC14071 | 1-7 | MC54156 | | MC75464 | 3-11 | MCBC5440 | 2-12 | MC194H31 | 2-13 | MC6810 | |
| MC14076 | 1-7 | MC54157 | | MC75491 | 3-8 | MCBC5450 | 2-12 | MC194H40 | 2-13 | MC6815 | |
| MC14081 | 3-7 | MC54164A | | MC75492 | 3-8 | MCBC5451 | 2-12 | MC194H51 | 2-13 | MC6830 | |
| | | MC54165 | | MTTL | | MCBC5453 | 2-12 | MC194H54 | 2-13 | MC6832 | |
| MC14410LP | 1-8 | MC54176 | | MC83151 | | MCBC5454 | 2-12 | MC194H56 | 2-13 | | |
| MC14411LP | 1-8 | MC54177 | | MC83152 | | MCBC5460 | 2-12 | MC194H57 | 2-13 | MECL | |
| MC14412FL | 1-8 | MC54180 | | MC83153 | | MCBC5472 | 2-12 | MC194H59 | 2-13 | MC610140 | 2-3 |
| MC14412VL | 1-8 | MC54181 | | MC93151 | | MCBC5473 | 2-12 | MC194H146 | 2-13 | MC610142 | 2-3 |
| MC14415FL | 1-8 | MC54182 | | MC93152 | | MCBC5479 | 2-12 | MC194H103 | 2-13 | MC610143 | 2-3 |
| MC14415FLVP | 1-8 | MC54192 | | MC93353 | | | | | | MC610144 | 2-3 |
| MC14415VLVP | 1-8 | MC54193 | | | | LINEAR | | DIODES | | MC610145 | 2-3 |
| MC14419LP | 1-8 | MC54195 | | | | MCCL436 | 3-35 | Current Limiting | | MC610147 | 2-3 |
| MC14435FL | 1-8 | MC54408 | | DIODES | | MCCL439 | 3-14 | MCCL300 | 4-82 | MC610148 | 2-3 |
| MC14435FLVP | 1-8 | MC54416 | 2-6 | Reference | | MCCL458 | | MCCL301 | 4-82 | MC610149 | 2-3 |
| MC14435VLVP | 1-8 | MC54417 | 2-6 | | | MCCL463 | | MCCL302 | 4-82 | | |
| MC14440LP | 1-8 | MC54418 | | MCAL911 | 4-81 | MCCL469 | | MCCL303 | 4-82 | MOS | |
| MC14450LP | 1-8 | MC54419 | 2-6 | MCAL912 | 4-81 | MCCL495 | | MCCL304 | 4-82 | MC614505 | 1-7 |
| MC14451LP | 1-8 | MC54452 | | MCAL913 | 4-81 | MCCL536 | 3-15 | | | MC614505A | 1-5 |
| MC14450FL | 1-8 | MC54453 | | MCAL921 | 4-81 | MCCL539 | 3-14 | Zener | | MC614524 | 1-7 |
| MC14450FLVP | 1-8 | MC54454 | | MCAL922 | 4-81 | MCCL558 | | MCCL6010 | 4-82 | MC614524A | 1-6 |
| MC14450VL | 1-8 | MC54455 | | MCAL923 | 4-81 | MCCL563 | | MCCL6025 | 4-82 | MC614524C | 1-6 |
| MC14450VLVP | 1-8 | MC54456 | | MCAL924 | 4-81 | MCCL569 | | MCCL6050 | 4-82 | MC614537 | 1-5 |
| MC14501 | 1-7 | MC54460 | | MCAL931 | 4-81 | MCCL585 | | MCCL6100 | 4-82 | MC614537A | 1-5 |
| MC14502 | 1-7 | MC54468 | | MCAL932 | 4-81 | MCCL709 | 3-14 | | | MC614537C | 1-5 |
| MC14506 | 1-7 | | | MCAL933 | 4-81 | MCCL709C | 3-14 | MOS | | MC614552 | 1-7 |
| MC14507 | 1-7 | LINEAR | | MCAL934 | 4-81 | MCCL710 | | MC612102 | 1-5 | MC614552A | 1-5 |
| MC14508 | 1-7 | MC55107 | 3-10 | MCAL935 | 4-81 | MCCL710C | | MC612102-1 | 1-5 | MC614552C | 1-5 |
| MC14510 | 1-7 | MC55108 | 3-10 | MCAL936 | 4-81 | MCCL711 | | MC612102-2 | 1-5 | | |
| MC14511 | 1-7 | MC55325 | 3-5 | MCAL937 | 4-81 | MCCL711C | | MC612102A | 1-5 | MC614552A | 1-5 |
| MC14512 | 1-7 | | | MCAL938 | 4-81 | MCCL723 | | MC612102A2 | 1-5 | MC614552A | 1-5 |
| MC14514 | 1-7 | MTTL | | MCAL939 | 4-81 | MCCL723C | | MC612102A4 | 1-5 | MC614570 | |
| MC14515 | 1-7 | MC74100 | | MCAL940 | 4-81 | MCCL741 | 3-15 | MC612111A | 1-5 | MC614571 | |
| MC14516 | 1-7 | MC74107 | | MCAL941 | 4-81 | MCCL741C | 3-15 | MC612111A2 | 1-5 | MC614573 | |
| MC14517 | 1-7 | MC74121 | | MCAL942 | 4-81 | MCCL748 | 3-14 | MC612111A4 | 1-5 | THYRISTORS | |
| MC14518 | 1-7 | MC74145 | | MCAL943 | 4-81 | MCCL748C | 3-14 | MC612112A | 1-5 | SCR | |
| MC14519 | 1-7 | MC74150 | | MCAL944 | 4-81 | | | MC612112A2 | 1-5 | MC614580-05 | 4-102 |
| MC14520 | 1-7 | MC74151 | | MCAL945 | 4-81 | MOS CHIPS | | MC612112A4 | 1-5 | MC614580-10 | 4-102 |
| MC14521 | 1-7 | MC74152 | | MCAL946 | 4-81 | MCCL4440 | 1-8 | | | MC614580-20 | 4-102 |
| MC14522 | 1-7 | MC74153 | | MCAL947 | 4-81 | MCCL4450 | 1-8 | | | MC614580-30 | 4-102 |
| MC14526 | 1-7 | MC74155 | | MCAL948 | 4-81 | MCCL4451 | 1-8 | | | MC614580-40 | 4-102 |
| MC14527 | 1-7 | MC74156 | | MCAL949 | 4-81 | | | | | MC614580-50 | 4-102 |
| MC14528 | 1-7 | MC74157 | | MCAL950 | 4-81 | LINEAR | | | | MC614580-60 | 4-102 |
| MC14529 | 1-7 | MC74164A | | MCAL951 | 4-81 | MCCL458 | 3-15 | | | MC614580-70 | 4-102 |
| MC14530 | 1-7 | MC74165 | | MCAL952 | 4-81 | MCCL458C | 3-15 | | | MC614580-80 | 4-102 |
| MC14531 | 1-7 | MC74176 | | MCAL953 | 4-81 | MCCL4709 | 3-14 | | | MC614580-90 | 4-102 |
| MC14532 | 1-7 | MC74177 | | MCAL954 | 4-81 | MCCL4709C | 3-14 | | | MC614581-05 | 4-102 |
| MC14534 | 1-7 | MC74180 | | MCAL955 | 4-81 | MCCL4711 | 3-15 | | | MC614581-10 | 4-102 |
| MC14536 | 1-7 | MC74181 | | MCAL956 | 4-81 | MCCL4711C | 3-15 | | | MC614581-20 | 4-102 |
| MC14539 | 1-7 | MC74182 | | MCAL957 | 4-81 | MCCL4711C | 3-15 | | | MC614581-30 | 4-102 |
| MC14541 | 1-7 | MC74192 | | MCAL958 | 4-81 | MDTL | | | | MC614581-40 | 4-102 |
| MC14543 | 1-7 | MC74193 | | MCAL959 | 4-81 | MCCL4711C | 3-15 | | | MC614581-50 | 4-102 |
| MC14549 | 1-7 | MC74195 | | MCAL960 | 4-81 | MCCL4711C | 3-15 | | | MC614581-60 | 4-102 |
| MC14553 | 1-7 | MC74408 | | MCAL961 | 4-81 | | | | | MC614581-70 | 4-102 |
| | | | | MCAL962 | 4-81 | | | | | MC614581-80 | 4-102 |

CATALOG INDEX (continued)

| DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE |
|-----------|-------|-------------------------|------------|------------|----------|----------|----------|----------|------|
| MCR82-05 | 4-102 | Pulse Modulator | | MCR3918-8 | | MD2904AF | 4-42 | MDA806 | 4-89 |
| MCR82-10 | 4-102 | | | MCR3918-9 | | MD2904F | 4-42 | MDA920-1 | |
| MCR82-20 | 4-102 | | | MCR3918-10 | 4-100 | MD2905 | 4-42 | MDA920A1 | |
| MCR82-30 | 4-102 | | | MCR3935-1 | 4-101 | MD2905A | | MDA920-2 | |
| MCR82-40 | 4-102 | | | MCR3935-2 | 4-101 | MD2905AF | | MDA920A2 | 4-89 |
| MCR82-50 | 4-102 | | | MCR3935-3 | | MD2905F | 4-42 | MDA920-3 | |
| MCR82-60 | 4-102 | SCR | | MCR3935-4 | | MD3250 | 4-44 | MDA920A3 | 4-89 |
| MCR82-70 | 4-102 | | | MCR3935-5 | 4-101 | MD3250A | 4-44 | MDA920-4 | |
| MCR82-80 | 4-102 | | | MCR3935-6 | | MD3250AF | 4-44 | MDA920A4 | 4-89 |
| MCR83-05 | 4-102 | | | MCR3935-7 | 4-101 | MD3250F | 4-44 | MDA920-5 | |
| MCR83-10 | 4-102 | | | MCR3935-8 | 4-101 | MD3251 | 4-44 | MDA920A5 | |
| MCR83-20 | 4-102 | | | MCR3935-9 | 4-101 | MD3251A | 4-44 | MDA920-6 | |
| MCR83-30 | 4-102 | | MCR3935-10 | 4-101 | MD3251AF | 4-44 | MDA920A6 | 4-89 | |
| MCR83-40 | 4-102 | Pulse Modulators | | MCR4018-1 | | MD3251F | 4-44 | MDA920-7 | |
| MCR83-50 | 4-102 | | | MCR4018-2 | | MD3409 | 4-42 | MDA920A7 | 4-89 |
| MCR83-60 | 4-102 | | | MCR4018-3 | | MD3410 | 4-42 | MDA922-1 | |
| MCR83-70 | 4-102 | | | MCR4018-4 | | MD3425 | | MDA922-2 | |
| MCR83-80 | 4-102 | | | MCR4018-5 | | MD3467 | 4-44 | MDA922-3 | |
| MCR101 | 4-98 | | | MCR4018-6 | | MD3467F | 4-44 | MDA922-4 | |
| MCR102 | 4-98 | | MCR4018-7 | | MD3725 | 4-44 | MDA922-5 | | |
| MCR103 | 4-98 | | MCR4018-8 | | MD3725F | 4-44 | MDA922-6 | | |
| MCR104 | 4-98 | | MCR4018-9 | | MD3762 | 4-44 | MDA922-7 | | |
| MCR105-1 | 4-98 | | MCR4018-10 | | MD3762F | 4-44 | MDA922-8 | | |
| MCR106-2 | 4-98 | | MCR4035-1 | | MD4260 | | MDA922-9 | | |
| MCR106-3 | 4-98 | | MCR4035-2 | | MD4261 | | MDA942-1 | | |
| MCR106-4 | 4-98 | | MCR4035-3 | | MD4957 | | MDA942A1 | | |
| MCR106-5 | 4-98 | SCR | | MCR4035-4 | | MD5000 | 4-43 | MDA942-2 | |
| MCR106-6 | 4-98 | | | MCR4035-5 | | MD5000A | 4-43 | MDA942A2 | |
| MCR106-7 | 4-98 | | | MCR4035-6 | | MD5000B | 4-43 | MDA942-3 | |
| MCR106-8 | 4-98 | | | MCR4035-7 | | MD6001 | 4-42 | MDA942A3 | |
| MCR106-9 | 4-98 | | | MCR4035-8 | | MD6001F | 4-42 | MDA942-4 | |
| MCR106-10 | 4-98 | | | MCR4035-9 | | MD6002 | 4-42 | MDA942A4 | |
| MCR107-1 | 4-98 | | MCR4035-10 | | MD6002F | 4-42 | MDA942-5 | | |
| MCR107-2 | 4-98 | TRANSISTORS SS Duals | | | | MD6003 | 4-42 | MDA942A5 | |
| MCR107-3 | 4-98 | | | | | MD6003F | 4-42 | MDA942-6 | |
| MCR107-4 | 4-98 | | | | | MD6100 | 4-41 | MDA942A6 | |
| MCR107-5 | 4-98 | | | | | MD6100F | 4-41 | MDA960-1 | |
| MCR107-6 | 4-98 | | | | | MD7000 | 4-42 | MDA960-2 | |
| MCR107-7 | 4-98 | | | | | MD7001 | 4-42 | MDA960-3 | |
| MCR107-8 | 4-98 | | | | MD7001F | 4-42 | MDA960-4 | | |
| MCR115 | 4-98 | | | | MD7002 | 4-41 | MDA960-5 | | |
| MCR120 | 4-98 | | | | MD7002A | 4-41 | MDA970-1 | 4-89 | |
| MCR220-5 | 4-98 | | | | MD7002B | 4-41 | MDA970-2 | 4-89 | |
| MCR220-6 | 4-98 | | | | MD7003 | 4-41 | MDA970-3 | 4-89 | |
| MCR220-7 | 4-98 | | | | MD7003A | 4-41 | MDA970-4 | | |
| MCR220-8 | 4-98 | | | | MD7003AF | 4-41 | MDA970-5 | 4-89 | |
| MCR221-5 | 4-98 | | | | MD7003B | 4-41 | MDA980-1 | 4-89 | |
| MCR221-7 | 4-98 | | | | MD7003F | 4-41 | MDA980-2 | 4-89 | |
| MCR221-9 | 4-98 | | | | MD7004 | | MDA980-3 | 4-89 | |
| MCR406-1 | 4-98 | | | | MD7004F | | MDA980-4 | | |
| MCR406-2 | 4-98 | | | | MD7005 | 4-43 | MDA980-5 | 4-89 | |
| MCR406-3 | 4-98 | | | | MD7005F | 4-43 | MDA980-6 | 4-89 | |
| MCR406-4 | 4-98 | | | | MD7007 | 4-44 | MDA990-1 | 4-89 | |
| MCR406-5 | 4-98 | | | | MD7007A | 4-44 | MDA990-2 | 4-89 | |
| MCR407-1 | 4-98 | | | | MD7007B | 4-44 | MDA990-3 | 4-89 | |
| MCR407-2 | 4-98 | | | | MD7007F | 4-44 | MDA990-4 | | |
| MCR407-3 | 4-98 | | | | MD7021 | 4-41 | MDA990-5 | 4-89 | |
| MCR407-4 | 4-98 | | | | MD7021F | 4-41 | MDA990-6 | 4-89 | |
| MCR49-1 | | RECTIFIERS Bridges | | | | MD8001 | 4-89 | MDA1200 | 4-89 |
| MCR49-2 | | | | | | MD8002 | | MDA1201 | 4-89 |
| MCR49-3 | | | | | | MD8003 | | MDA1202 | 4-89 |
| MCR49-4 | | | | | | | | MDA1204 | 4-89 |
| MCR49-5 | | | | | | | | MDA1206 | 4-89 |
| MCR49-6 | | | | | | | | MDA1208 | 4-89 |
| MCR49-7 | | | | | | | MDA1209 | 4-89 | |
| MCR49-8 | | | | | | | MDA1210 | 4-89 | |
| MCR49-9 | 4-101 | | | | | | MDA1211 | 4-89 | |
| MCR49-10 | 4-101 | | | | | | MDA1212 | 4-89 | |
| MCR49P1 | | | | | | | MDA1213 | 4-89 | |
| MCR49P2 | | | | | | | MDA1214 | 4-89 | |
| MCR49P3 | | | | | | | MDA1215 | 4-89 | |
| MCR49P4 | | | | | | | MDA1216 | 4-89 | |
| MCR49P5 | | | | | | | MDA1217 | 4-89 | |
| MCR49P6 | | | | | | | MDA1218 | 4-89 | |
| MCR49P7 | | | | | | | MDA1219 | 4-89 | |
| MCR49P8 | | | | | | | MDA1220 | 4-89 | |
| MCR49AP1 | 4-101 | | | | | | MDA1221 | 4-89 | |
| MCR49AP2 | 4-101 | | | | | | MDA1222 | 4-89 | |
| MCR49AP3 | 4-101 | | | | | | MDA1223 | 4-89 | |
| MCR49AP4 | 4-101 | | | | | | MDA1224 | 4-89 | |
| MCR49AP5 | 4-101 | | | | | | MDA1225 | 4-89 | |
| MCR49AP6 | 4-101 | | | | | | MDA1226 | 4-89 | |
| MCR49AP7 | 4-101 | | | | | | MDA1227 | 4-89 | |
| MCR49AP8 | 4-101 | | | | | | MDA1228 | 4-89 | |
| | | | | | | | MDA1229 | 4-89 | |
| | | | | | | | MDA1230 | 4-89 | |
| | | | | | | | MDA1231 | 4-89 | |
| | | | | | | | MDA1232 | 4-89 | |
| | | | | | | | MDA1233 | 4-89 | |
| | | | | | | | MDA1234 | 4-89 | |
| | | | | | | | MDA1235 | 4-89 | |
| | | | | | | | MDA1236 | 4-89 | |
| | | | | | | | MDA1237 | 4-89 | |
| | | | | | | | MDA1238 | 4-89 | |
| | | | | | | | MDA1239 | 4-89 | |
| | | | | | | | MDA1240 | 4-89 | |
| | | | | | | | MDA1241 | 4-89 | |
| | | | | | | | MDA1242 | 4-89 | |
| | | | | | | | MDA1243 | 4-89 | |
| | | | | | | | MDA1244 | 4-89 | |
| | | | | | | | MDA1245 | 4-89 | |
| | | | | | | | MDA1246 | 4-89 | |
| | | | | | | | MDA1247 | 4-89 | |
| | | | | | | | MDA1248 | 4-89 | |
| | | | | | | | MDA1249 | 4-89 | |
| | | | | | | | MDA1250 | 4-89 | |
| | | | | | | | MDA1251 | 4-89 | |
| | | | | | | | MDA1252 | 4-89 | |
| | | | | | | | MDA1253 | 4-89 | |
| | | | | | | | MDA1254 | 4-89 | |
| | | | | | | | MDA1255 | 4-89 | |
| | | | | | | | MDA1256 | 4-89 | |
| | | | | | | | MDA1257 | 4-89 | |
| | | | | | | | MDA1258 | 4-89 | |
| | | | | | | | MDA1259 | 4-89 | |
| | | | | | | | MDA1260 | 4-89 | |
| | | | | | | | MDA1261 | 4-89 | |
| | | | | | | | MDA1262 | 4-89 | |
| | | | | | | | MDA1263 | 4-89 | |
| | | | | | | | MDA1264 | 4-89 | |
| | | | | | | | MDA1265 | 4-89 | |
| | | | | | | | MDA1266 | 4-89 | |
| | | | | | | | MDA1267 | 4-89 | |
| | | | | | | | MDA1268 | 4-89 | |
| | | | | | | | MDA1269 | 4-89 | |
| | | | | | | | MDA1270 | 4-89 | |
| | | | | | | | MDA1271 | 4-89 | |
| | | | | | | | MDA1272 | 4-89 | |
| | | | | | | | MDA1273 | 4-89 | |
| | | | | | | | MDA1274 | 4-89 | |
| | | | | | | | MDA1275 | 4-89 | |
| | | | | | | | MDA1276 | 4-89 | |
| | | | | | | | MDA1277 | 4-89 | |
| | | | | | | | MDA1278 | 4-89 | |
| | | | | | | | MDA1279 | 4-89 | |
| | | | | | | | MDA1280 | 4-89 | |
| | | | | | | | MDA1281 | 4-89 | |
| | | | | | | | MDA1282 | 4-89 | |
| | | | | | | | MDA1283 | 4-89 | |
| | | | | | | | MDA1284 | 4-89 | |
| | | | | | | | MDA1285 | 4-89 | |
| | | | | | | | MDA1286 | 4-89 | |
| | | | | | | | MDA1287 | 4-89 | |
| | | | | | | | MDA1288 | 4-89 | |
| | | | | | | | MDA1289 | 4-89 | |
| | | | | | | | MDA1290 | 4-89 | |
| | | | | | | | MDA1291 | 4-89 | |
| | | | | | | | MDA1292 | 4-89 | |
| | | | | | | | MDA1293 | 4-89 | |
| | | | | | | | MDA1294 | 4-89 | |
| | | | | | | | MDA1295 | 4-89 | |
| | | | | | | | MDA1296 | 4-89 | |
| | | | | | | | MDA1297 | 4-89 | |
| | | | | | | | MDA1298 | 4-89 | |
| | | | | | | | MDA1299 | 4-89 | |
| | | | | | | | MDA1300 | 4-89 | |
| | | | | | | | MDA1301 | 4-89 | |
| | | | | | | | MDA1302 | 4-89 | |
| | | | | | | | MDA1303 | 4-89 | |
| | | | | | | | MDA1304 | 4-89 | |
| | | | | | | | MDA1305 | 4-89 | |
| | | | | | | | MDA1306 | 4-89 | |
| | | | | | | | MDA1307 | 4-89 | |
| | | | | | | | MDA1308 | 4-89 | |
| | | | | | | | MDA1309 | 4-89 | |
| | | | | | | | MDA1310 | 4-89 | |
| | | | | | | | MDA1311 | 4-89 | |
| | | | | | | | MDA1312 | 4-89 | |
| | | | | | | | MDA1313 | 4-89 | |
| | | | | | | | MDA1314 | 4-89 | |
| | | | | | | | MDA1315 | 4-89 | |
| | | | | | | | MDA1316 | 4-89 | |
| | | | | | | | MDA1317 | 4-89 | |
| | | | | | | | MDA1318 | 4-89 | |
| | | | | | | | MDA1319 | 4-89 | |
| | | | | | | | MDA1320 | 4-89 | |
| | | | | | | | MDA1321 | 4-89 | |
| | | | | | | | MDA1322 | 4-89 | |
| | | | | | | | MDA1323 | 4-89 | |
| | | | | | | | MDA1324 | 4-89 | |
| | | | | | | | MDA1325 | 4-89 | |
| | | | | | | | MDA1326 | 4-89 | |
| | | | | | | | MDA1327 | 4-89 | |
| | | | | | | | MDA1328 | 4-89 | |
| | | | | | | | MDA1329 | 4-89 | |
| | | | | | | | MDA1330 | 4-89 | |
| | | | | | | | MDA1331 | 4-89 | |
| | | | | | | | MDA1332 | 4-89 | |
| | | | | | | | MDA1333 | 4-89 | |
| | | | | | | | MDA1334 | 4-89 | |
| | | | | | | | MDA1335 | 4-89 | |
| | | | | | | | MDA1336 | 4-89 | |
| | | | | | | | MDA1337 | 4-89 | |
| | | | | | | | MDA1338 | 4-89 | |
| | | | | | | | MDA1339 | 4-89 | |
| | | | | | | | MDA1340 | 4-89 | |
| | | | | | | | MDA1341 | 4-89 | |
| | | | | | | | MDA1342 | 4-89 | |
| | | | | | | | MDA1343 | 4-89 | |
| | | | | | | | MDA1344 | 4-89 | |
| | | | | | | | MDA1345 | 4-89 | |
| | | | | | | | MDA13 | | |

CATALOG INDEX (continued)

| DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE |
|-----------|------|-------------|------|---------|------|---------------|------|----------------|-------|-------------|------|
| MHW570 | 4-61 | MJ3260 | | MJE103 | | MJE2020 | | MK15B | | LINEAR | |
| MHW572 | 4-61 | MJ3430 | | MJE104 | | MJE2021 | | MK20 | | MM101A | 3-14 |
| MHW580 | 4-61 | MJ3480 | | MJE105 | | MJE2050 | | MK20B | | MM104 | |
| MHW601 | 4-55 | MJ3701 | | MJE105K | | MJE2055 | | MK25 | | MM105 | |
| MHW602 | 4-55 | MJ3702 | | MJE170 | | MJE2090 | | MK25B | | MM107 | 3-15 |
| MHW709-1 | 4-56 | MJ3703 | | MJE171 | | MJE2091 | | MK30 | | MM109 | |
| MHW709-2 | 4-56 | MJ3704 | | MJE172 | | MJE2092 | | MK30B | | MM110 | 3-15 |
| MHW709-3 | 4-56 | MJ3760 | 4-5 | MJE180 | | MJE2093 | | MK35 | | MM111 | 3-13 |
| MHW710-1 | 4-56 | MJ3761 | 4-5 | MJE181 | | MJE2100 | | MK35B | | MM124 | |
| MHW710-2 | 4-56 | MJ3771 | | MJE182 | | MJE2101 | | MK77-1 | | MM139 | 3-24 |
| MHW710-3 | 4-56 | MJ3772 | | MJE200 | 4-5 | MJE2102 | | MK77-1B | | MM139A | 3-24 |
| | | MJ3773 | | MJE201 | | MJE2103 | | MK77-2 | | MM201A | |
| Pwr Metal | | MJ4031 | | MJE202 | | MJE2150 | | MK77-2B | | MM204 | |
| MJ205 | 4-4 | MJ4032 | | MJE203 | | MJE2160 | 4-3 | MK77-3B | | MM205 | |
| MJ400 | | MJ4033 | | MJE204 | | MJE2360 | | MK90-1 | | MM207 | 3-15 |
| MJ410 | | MJ4034 | | MJE205 | | MJE2361 | | MK90-1B | | MM209 | |
| MJ411 | | MJ4035 | | MJE205K | | MJE2370 | | MK90-2 | | MM210 | 3-15 |
| MJ413 | 4-9 | MJ4200 | | MJE210 | 4-5 | MJE2480 | | MK90-2B | | MM211 | 3-13 |
| MJ420 | | MJ4201 | | MJE220 | | MJE2481 | | MK90-3 | | MM224 | |
| MJ420s | | MJ4210 | | MJE221 | | MJE2482 | | MK90-3B | | MM239 | 3-24 |
| MJ421 | | MJ4211 | | MJE222 | | MJE2483 | | MK90-4 | | MM239A | 3-24 |
| MJ421s | | MJ4502 | 4-7 | MJE223 | | MJE2490 | | MK90-4B | | MM301A | 3-14 |
| MJ423 | 4-9 | MJ4645 | | MJE224 | | MJE2491 | | MK90-5 | | MM304 | |
| MJ424 | | MJ4646 | | MJE225 | | MJE2520 | | MK90-5B | | MM305 | |
| MJ425 | 4-5 | MJ4647 | | MJE230 | | MJE2801 | | MK90-6 | | MM307 | 3-15 |
| MJ430s | | MJ4648 | | MJE231 | | MJE2801K | | MK90-6B | | MM309 | |
| MJ431 | | MJ5038 | | MJE232 | | MJE2901 | | MK90-7 | | MM310 | 3-15 |
| MJ440s | | MJ5039 | | MJE233 | | MJE2901K | | MK90-7B | | MM311 | 3-13 |
| MJ450 | | MJ5415 | 4-3 | MJE234 | | MJE2955 | | MK90-8 | | MM324 | |
| MJ480 | | MJ5416 | 4-3 | MJE235 | | MJE2955K | | MK90-8B | | MM339 | 3-24 |
| MJ481 | | MJ6302 | | MJE240 | | MJE3055 | | MK90-9 | | MM339A | 3-24 |
| MJ490 | | MJ6700 | | MJE241 | | MJE3055K | | MK90-9B | | | |
| MJ491 | | MJ6701 | | MJE242 | | MJE3300 | 4-4 | MK90-10B | | TRANSISTORS | |
| MJ701 | | MJ7000 | | MJE243 | | MJE3301 | 4-4 | | | SS Metal | |
| MJ702 | | MJ7160 | 4-5 | MJE244 | | MJE3302 | 4-4 | MK100 | | MM1500 | |
| MJ704 | | MJ7161 | 4-5 | MJE250 | | MJE3310 | 4-4 | MK100B | | MM1500A | |
| MJ721 | | MJ7260 | 4-9 | MJE251 | | MJE3311 | 4-4 | MK126 | | MM1501 | |
| MJ723 | | MJ7261 | 4-9 | MJE252 | | MJE3312 | 4-4 | MK167 | | MM1505 | |
| MJ802 | 4-7 | MJ8020 | | MJE253 | | MJE3370 | | MK167B | | MM1553 | |
| MJ804 | 4-5 | MJ8100 | | MJE254 | | MJE3371 | | MK189 | | MM1748 | |
| MJ900 | 4-8 | MJ8101 | | MJE340 | 4-3 | MJE3439 | 4-3 | MK189B | | MM1748A | |
| MJ901 | | MJ9800 | | MJE340K | 4-3 | MJE3440 | 4-3 | MK191 | | MM1941 | 4-18 |
| MJ920 | | | | MJE341 | | MJE3520 | | MK199-1B | | MM2005-2 | |
| MJ921 | | Pwr Plastic | | MJE341K | | MJE3521 | | MK199-2 | | MM2258 | 4-17 |
| MJ1000 | 4-8 | MJE29 | 4-3 | MJE344 | | MJE3738 | | MK199-2B | | MM2259 | 4-17 |
| MJ1001 | | MJE29A | 4-3 | MJE344K | | MJE3739 | | MK199-3B | | MM2260 | |
| MJ1200 | | MJE29B | 4-3 | MJE345 | | MJE4918 | | MK199-4 | | MM2484 | |
| MJ1201 | | MJE29C | 4-3 | MJE350 | 4-3 | MJE4919 | | MK199-4B | | MM3000 | |
| MJ1800 | | MJE30 | 4-3 | MJE370 | | MJE4920 | | MK199-5B | | MM3001 | 4-17 |
| MJ2249 | | MJE30A | 4-3 | MJE370K | | MJE4921 | | MK199-5B | | MM3002 | 4-17 |
| MJ2250 | | MJE30B | 4-3 | MJE371 | | MJE4922 | | MK199-6B | | MM3003 | 4-17 |
| MJ2251 | | MJE30C | 4-3 | MJE371K | | MJE4923 | | MK221-1 | | MM3005 | 4-17 |
| MJ2252 | | MJE31 | 4-4 | MJE520 | 4-4 | MJE5190 | 4-4 | MK221-1B | | MM3006 | 4-17 |
| MJ2253 | 4-4 | MJE31A | 4-4 | MJE520K | | MJE5191 | 4-4 | MK221-2B | | MM3007 | 4-17 |
| MJ2254 | | MJE31B | 4-4 | MJE521 | | MJE5192 | 4-4 | | | MM3008 | 4-17 |
| MJ2267 | | MJE31C | 4-4 | MJE521K | | MJE5193 | 4-4 | | | MM3009 | 4-17 |
| MJ2268 | | MJE32 | 4-4 | MJE700 | 4-4 | MJE5194 | 4-4 | LIQUID CRYSTAL | | MM3019 | |
| MJ2500 | | MJE32A | 4-4 | MJE701 | | MJE5195 | 4-4 | DISPLAY | | MM3020 | |
| MJ2501 | | MJE32B | 4-4 | MJE702 | 4-44 | MJE5655 | 4-3 | MIC400 | | MM3053 | 4-19 |
| MJ2801 | | MJE32C | 4-4 | MJE703 | | MJE5656 | 4-3 | MIC500 | | MM3220 | |
| MJ2802 | | MJE33 | | MJE710 | | MJE5657 | 4-3 | MIC501 | | MM3726 | 4-16 |
| MJ2840 | | MJE33A | | MJE711 | | MJE5974 | 4-5 | | | MM3734 | 4-15 |
| MJ2841 | | MJE33B | | MJE712 | | MJE5975 | 4-5 | | | MM3735 | |
| MJ2901 | | MJE33C | | MJE720 | | MJE5976 | 4-5 | OPTOS | | MM3736 | 4-15 |
| MJ2940 | | MJE34 | | MJE721 | | MJE5977 | 4-5 | LED | | MM3737 | 4-15 |
| MJ2941 | | MJE34A | | MJE722 | | MJE5978 | 4-5 | ME050 | 4-110 | MM3903 | 4-15 |
| MJ2955 | | MJE34B | | MJE800 | 4-4 | MJE5979 | 4-5 | ME055 | 4-110 | MM3904 | 4-15 |
| MJ3000 | | MJE34C | | MJE801 | | MJE5980 | 4-5 | ME060 | 4-110 | MM3905 | 4-16 |
| MJ3001 | | MJE41 | 4-5 | MJE802 | 4-44 | MJE5981 | 4-5 | ME090 | 4-111 | MM3906 | 4-16 |
| MJ3010 | | MJE41A | 4-5 | MJE803 | | MJE5982 | 4-5 | ME092 | 4-111 | MM4000 | 4-18 |
| MJ3011 | | MJE41B | 4-5 | MJE1090 | 4-5 | MJE5983 | 4-5 | ME0440 | 4-110 | MM4001 | 4-16 |
| MJ3012 | | MJE41C | 4-5 | MJE1091 | | MJE5984 | 4-5 | ME0445 | | MM4002 | 4-18 |
| MJ3026 | | MJE42 | 4-5 | MJE1092 | | MJE5985 | 4-5 | ME0500 | | MM4003 | 4-18 |
| MJ3027 | | MJE42A | 4-5 | MJE1093 | | MJE6040 | | ME0600 | 4-110 | MM4005 | 4-16 |
| MJ3028 | | MJE42B | 4-5 | MJE1100 | 4-5 | MJE6041 | | ME0610 | | MM4006 | 4-16 |
| MJ3029 | | MJE42C | 4-5 | MJE1101 | | MJE6042 | | ME0640 | 4-110 | MM4007 | 4-16 |
| MJ3030 | | MJE47 | 4-3 | MJE1102 | | MJE6043 | | ME0655 | 4-110 | MM4008 | 4-20 |
| MJ3040 | | MJE48 | 4-9 | MJE1103 | | MJE6044 | | ME0660 | 4-110 | MM4009 | 4-18 |
| MJ3041 | | MJE49 | 4-9 | MJE1290 | | MJE6045 | | ME0900 | 4-111 | MM4010 | 4-18 |
| MJ3042 | | MJE51 | 4-5 | MJE1291 | | | | ME0910 | 4-111 | | |
| MJ3055 | | MJE52 | 4-5 | MJE1660 | | MTG HDWR KITS | | ME0930 | 4-111 | RF | |
| MJ3101 | | MJE53 | 4-5 | MJE1661 | | MK10 | | | | MM4018 | |
| MJ3201 | | MJE101 | | MJE2010 | | MK10B | | | | MM4019 | |
| MJ3202 | | MJE102 | | MJE2011 | | MK15 | | | | | |

CATALOG INDEX (continued)

| DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE |
|--------------------|------|--------------------|-------|----------------------|------|----------------|------|----------------|------|
| SS Metal | | TRANSISTORS | | PIN | | MPS2716 | | MPS6567 | |
| MM4030..... | 4-16 | MICRO-T | | MPN3401..... | 4-72 | MPS2907..... | 4-26 | MPS6568..... | 4-25 |
| MM4031..... | 4-16 | MM170..... | | MPN3402..... | 4-72 | MPS2923..... | | MPS6568A..... | |
| MM4032..... | 4-16 | MM171..... | | MPN3403..... | | MPS2924..... | | MPS6569..... | 4-25 |
| MM4033..... | 4-16 | MM172..... | | MPN3404..... | | MPS2925..... | | MPS6569A..... | |
| MM4036..... | 4-16 | MM173..... | | MPN3411..... | 4-72 | MPS2926..... | | MPS6570..... | 4-25 |
| MM4037..... | 4-16 | MM174..... | | MPN3412..... | 4-72 | MPS3013..... | | MPS6570A..... | |
| RF | | MM175..... | 4-48 | MPN3601..... | | MPS3390..... | | MPS6571..... | 4-27 |
| MM4049..... | 4-60 | MM176..... | 4-48 | | | MPS3391..... | | MPS6573..... | |
| SS Metal | | MM1806..... | | TRANSISTORS | | MPS3391A..... | | MPS6574..... | |
| MM4052..... | | MM1807..... | | Plastic Quads | | MPS3392..... | | MPS6575..... | |
| MM4208..... | | MM1808..... | | MPQ918..... | 4-39 | MPS3393..... | | MPS6576..... | |
| MM4208A..... | | MM1809..... | | MPQ1000..... | 4-37 | MPS3394..... | | MPS6579..... | |
| MM4209..... | | MM1918..... | 4-48 | MPQ1000N..... | | MPS3395..... | | MPS6580..... | |
| MM4209A..... | | MM1930..... | | MPQ1050..... | 4-38 | MPS3396..... | | MPS6580A..... | |
| MM4257..... | 4-16 | MM12222..... | 4-48 | MPQ1500..... | 4-37 | MPS3397..... | | MPS65800..... | |
| MM4258..... | 4-16 | MM12369..... | 4-49 | MPQ1500N..... | | MPS3398..... | | MPS65801..... | |
| MM5005..... | 4-18 | MM12484..... | 4-49 | MPQ2001..... | 4-39 | MPS3398A..... | | MPS65809..... | 4-27 |
| MM5005..... | 4-18 | MM12857..... | 4-48 | MPQ2221..... | 4-37 | MPS3563..... | | MPS65809..... | 4-24 |
| MM5007..... | 4-18 | MM12907..... | 4-48 | MPQ2221N..... | | MPS3567..... | | MPS6588..... | 4-24 |
| MM5189..... | 4-15 | MM13014..... | 4-49 | MPQ2222..... | 4-37 | MPS3568..... | | MPS6589..... | 4-26 |
| MM5262..... | | MM13546..... | 4-49 | MPQ2222N..... | | MPS3569..... | | MPS6590..... | 4-24 |
| MM6427..... | 4-17 | MM13798..... | | MPQ2369..... | 4-39 | MPS3638..... | | MPS6596..... | 4-24 |
| RF | | MM13799..... | 4-49 | MPQ2483..... | 4-38 | MPS3638A..... | | MPS6599..... | 4-27 |
| MM8000..... | | MM13823..... | 4-50 | MPQ2484..... | 4-38 | MPS3639..... | 4-25 | MPS6600..... | |
| MM8001..... | | MM13903..... | 4-48 | MPQ2906..... | 4-37 | MPS3640..... | 4-25 | MPS6600A..... | |
| MM8002..... | | MM13904..... | 4-48 | MPQ2906N..... | | MPS3646..... | 4-25 | MPS6601..... | |
| MM8003..... | | MM13905..... | 4-48 | MPQ2907..... | 4-37 | MPS3693..... | | MPS6601N..... | |
| MM8004..... | | MM13906..... | 4-48 | MPQ3003..... | 4-38 | MPS3694..... | | MPQ3003..... | 4-37 |
| MM8005..... | | MM13960A..... | | MPQ3033..... | 4-38 | MPS3702..... | 4-26 | MPQ3033..... | 4-38 |
| MM8007..... | | MM14261..... | 4-48 | MPQ3467..... | 4-39 | MPS3703..... | | MPQ3467..... | 4-38 |
| MM8008..... | | MM18015..... | | MPQ3546..... | 4-38 | MPS3704..... | 4-26 | MPQ3546..... | 4-38 |
| MM8009..... | 4-59 | MM18051..... | 4-48 | MPQ3725A..... | 4-38 | MPS3706..... | | MPQ3725A..... | 4-38 |
| MM8010..... | | OPTOS | | MPQ3762..... | 4-38 | MPS3707..... | | MPQ3762..... | 4-38 |
| MM8011..... | | Coupler | | MPQ3798..... | 4-38 | MPS3710..... | | MPQ3798..... | 4-38 |
| MM8023..... | | MOCL119..... | 4-109 | MPQ3799..... | 4-3 | MPS3711..... | | MPQ3799..... | 4-3 |
| MICRO-T | | MOCL1005..... | 4-109 | MPQ3904..... | 4-37 | MPS3826..... | | MPQ3904..... | 4-37 |
| MMCM918..... | | MOCL1006..... | 4-109 | MPQ3906..... | 4-37 | MPS3827..... | | MPQ3906..... | 4-37 |
| MMCM930..... | | MOCL1200..... | 4-109 | MPQ4003..... | 4-38 | MPS3903..... | 4-24 | MPQ4003..... | 4-38 |
| MMCM2221..... | 4-48 | MOCL1261..... | 4-109 | MPQ4004..... | 4-38 | MPS3904..... | 4-24 | MPQ4004..... | 4-38 |
| MMCM2369..... | 4-49 | MOC2000..... | 4-109 | MPQ6001..... | 4-37 | MPS3905..... | 4-24 | MPQ6001..... | 4-37 |
| MMCM2484..... | 4-49 | MOC3000..... | | MPQ6001N..... | | MPS3906..... | 4-24 | MPQ6001N..... | |
| MMCM2857..... | | MOC3002..... | | MPQ6002..... | 4-37 | MPS4257..... | | MPQ6002..... | 4-37 |
| MMCM2907..... | 4-48 | MOC3003..... | | MPQ6002N..... | 4-38 | MPS4258..... | | MPQ6002N..... | 4-38 |
| MMCM3798..... | | MOC5000..... | 4-109 | MPQ6100A..... | 4-38 | MPS4354..... | | MPQ6100A..... | 4-38 |
| MMCM3799..... | 4-49 | MOC5001..... | 4-109 | MPQ6426..... | 4-44 | MPS4355..... | | MPQ6426..... | 4-44 |
| MMCM3903..... | 4-48 | MOC8030..... | 4-109 | MPQ6501..... | 4-37 | MPS4356..... | | MPQ6501..... | 4-37 |
| MMCM3904..... | 4-48 | MOC8050..... | 4-109 | MPQ6501N..... | | MPS5172..... | | MPQ6501N..... | |
| MMCM3905..... | 4-48 | REGULATORS | | TRANSISTORS | | MPS6507..... | 4-25 | MPS6507..... | 4-25 |
| MMCM3906..... | 4-48 | Pwr | | Plastic Quads | | MPS6511..... | 4-25 | MPS6511..... | 4-25 |
| MMCM3960A..... | | MPC900..... | 4-10 | MPQ6502..... | 4-37 | MPS6512..... | | MPS6512..... | 4-25 |
| DIODES | | MPC1000..... | 4-10 | MPQ6502N..... | | MPS6513..... | | MPS6513..... | 4-26 |
| MICRO-T | | TRANSISTORS | | MPQ6600..... | | MPS6514..... | 4-26 | MPS6514..... | 4-26 |
| MMD70..... | | FET | | MPQ6600A..... | 4-38 | MPS6515..... | 4-24 | MPS6515..... | 4-24 |
| MMD6050..... | 4-50 | MPF102..... | 4-33 | MPQ6700..... | | MPS6516..... | | MPS6516..... | 4-25 |
| MMD6100..... | 4-50 | MPF108..... | 4-31 | MPQ6842..... | 4-40 | MPS6517..... | 4-26 | MPS6517..... | 4-26 |
| MMD6150..... | 4-50 | MPF111..... | 4-31 | MPQ7041..... | 4-39 | MPS6518..... | 4-24 | MPS6518..... | 4-24 |
| MMD7000..... | 4-50 | MPF112..... | | MPQ7042..... | 4-39 | MPS6519..... | 4-27 | MPS6519..... | 4-27 |
| MMD7001..... | | MPF120..... | | MPQ7043..... | 4-39 | MPS6520..... | 4-27 | MPS6520..... | 4-27 |
| TRANSISTORS | | MPF121..... | | MPQ7051..... | 4-39 | MPS6522..... | 4-27 | MPS6522..... | 4-27 |
| FET | | MPF122..... | | MPQ7052..... | 4-39 | MPS6523..... | 4-27 | MPS6523..... | 4-27 |
| MMF1..... | | MPF130..... | 4-33 | MPQ7053..... | 4-39 | MPS6530..... | | MPS6530..... | 4-24 |
| MMF2..... | | MPF131..... | 4-33 | MPQ7054..... | 4-39 | MPS6531..... | 4-24 | MPS6531..... | 4-24 |
| MMF3..... | | MPF132..... | 4-33 | MPQ7091..... | 4-39 | MPS6532..... | | MPS6532..... | 4-24 |
| MMF4..... | | MPF161..... | 4-31 | MPQ7092..... | 4-39 | MPS6533..... | 4-24 | MPS6533..... | 4-24 |
| MMF5..... | | MPF256..... | 4-33 | MPQ7093..... | 4-39 | MPS6534..... | | MPS6534..... | 4-24 |
| MMF6..... | | MPF820..... | | SS Plastic | | MPS6539..... | | MPS6539..... | 4-25 |
| LINEAR | | MPF970..... | 4-32 | MP5404..... | | MPS6540..... | | MPS6540..... | 4-25 |
| MMH0026..... | 3-4 | MPF971..... | 4-32 | MP5404A..... | | MPS6541..... | 4-25 | MPS6541..... | 4-25 |
| MMH0026C..... | 3-4 | MPF4391..... | 4-32 | MP5706..... | 4-25 | MPS6543..... | 4-25 | MPS6543..... | 4-25 |
| MMH0026C..... | | MPF4392..... | 4-32 | MP5708..... | | MPS6544..... | | MPS6544..... | 4-25 |
| | | MPF4393..... | 4-32 | MPS834..... | 4-25 | MPS6545..... | | MPS6545..... | 4-25 |
| DIODES | | VVC | | MPS835..... | 4-25 | MPS6546..... | 4-25 | MPS6546..... | 4-25 |
| MP13401..... | 4-72 | MP13401..... | 4-72 | MPS835..... | 4-25 | MPS6548..... | 4-25 | MPS6548..... | 4-25 |
| | | | | MPS835..... | 4-25 | MPS6550..... | | MPS6550..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6551..... | | MPS6551..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6552..... | | MPS6552..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6553..... | | MPS6553..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6554..... | | MPS6554..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6555..... | | MPS6555..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6556..... | | MPS6556..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6557..... | | MPS6557..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6558..... | | MPS6558..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6559..... | | MPS6559..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6560..... | | MPS6560..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6561..... | | MPS6561..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6562..... | | MPS6562..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6563..... | | MPS6563..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6564..... | | MPS6564..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6565..... | | MPS6565..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6566..... | | MPS6566..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6567..... | | MPS6567..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6568..... | | MPS6568..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6569..... | | MPS6569..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6570..... | | MPS6570..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6571..... | | MPS6571..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6572..... | | MPS6572..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6573..... | | MPS6573..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6574..... | | MPS6574..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6575..... | | MPS6575..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6576..... | | MPS6576..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6577..... | | MPS6577..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6578..... | | MPS6578..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6579..... | | MPS6579..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6580..... | | MPS6580..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6581..... | | MPS6581..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6582..... | | MPS6582..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6583..... | | MPS6583..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6584..... | | MPS6584..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6585..... | | MPS6585..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6586..... | | MPS6586..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6587..... | | MPS6587..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6588..... | | MPS6588..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6589..... | | MPS6589..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6590..... | | MPS6590..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6591..... | | MPS6591..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6592..... | | MPS6592..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6593..... | | MPS6593..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6594..... | | MPS6594..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6595..... | | MPS6595..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6596..... | | MPS6596..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6597..... | | MPS6597..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6598..... | | MPS6598..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6599..... | | MPS6599..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6600..... | | MPS6600..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6601..... | | MPS6601..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6602..... | | MPS6602..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6603..... | | MPS6603..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6604..... | | MPS6604..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6605..... | | MPS6605..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6606..... | | MPS6606..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6607..... | | MPS6607..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6608..... | | MPS6608..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6609..... | | MPS6609..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6610..... | | MPS6610..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6611..... | | MPS6611..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6612..... | | MPS6612..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6613..... | | MPS6613..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6614..... | | MPS6614..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6615..... | | MPS6615..... | 4-27 |
| | | | | MPS835..... | 4-25 | MPS6616..... | </ | | |

CATALOG INDEX (continued)

| DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE |
|---------|------|----------|------|---------|-------|-----------|------|--------|------|--------|------|
| MR250-1 | 4-92 | MR1130 | 4-87 | MRD810 | 4-111 | MRFB17 | 4-56 | MY1660 | 4-69 | MZ805 | |
| MR250-2 | 4-92 | MR1205FL | 4-88 | MRD3050 | 4-117 | MRFB18 | 4-56 | MY1662 | 4-69 | MZ810 | 4-81 |
| MR250-3 | 4-92 | MR1209FL | 4-88 | MRD3051 | 4-112 | MRFB23 | 4-56 | MY1664 | 4-69 | MZ870 | 4-81 |
| MR250-4 | 4-97 | MR1215FL | 4-88 | MRD3054 | 4-112 | MRFB24 | 4-56 | MY1666 | 4-69 | MZ880 | 4-81 |
| MR250-5 | 4-92 | MR1215SL | 4-88 | MRD3055 | 4-112 | MRFB25 | 4-56 | | | MZ821 | |
| MR327 | | MR1219FL | 4-88 | MRD3056 | 4-112 | MRFB35 | 4-56 | | | MZ821A | |
| MR328 | | MR1219SL | 4-88 | | | MRFB301 | 4-59 | | | MZ823 | |
| MR330 | | MR1245FL | 4-88 | | | MRFB305 | 4-59 | | | MZ823A | |
| MR331 | | MR1249FL | 4-88 | | | MRFB5174 | 4-59 | | | MZ825 | |
| MR500 | 4-86 | MR1245SL | 4-88 | | | MRFB5175 | 4-58 | | | MZ825A | |
| MR501 | 4-86 | MR1249SL | 4-88 | | | MRFB5176 | 4-58 | | | MZ827 | |
| MR502 | 4-86 | MR1262FL | 4-88 | | | MRFB5177 | 4-58 | | | MZ827A | |
| MR504 | 4-86 | MR1265FL | 4-88 | | | MRFB5177A | 4-58 | | | MZ835 | |
| MR506 | 4-86 | MR1269FL | 4-88 | | | MRFB004 | 4-53 | | | MZ935A | |
| MR508 | 4-86 | MR1366 | 4-91 | | | | | | | MZ935B | |
| MR510 | 4-86 | MR1376 | 4-91 | | | | | | | MZ936 | |
| MR750 | 4-86 | MR1386 | 4-91 | | | | | | | MZ936A | |
| MR751 | 4-86 | MR1396 | 4-91 | | | | | | | MZ936B | |
| MR752 | 4-86 | MR1815SL | 4-88 | | | | | | | MZ937 | |
| MR754 | 4-86 | MR1819SL | 4-88 | | | | | | | MZ937A | |
| MR756 | 4-86 | MR2000S | 4-87 | | | | | | | MZ937B | |
| MR800 | 4-91 | MR2001S | 4-87 | | | | | | | MZ938 | |
| MR801 | 4-91 | MR2002S | 4-87 | | | | | | | MZ938A | |
| MR802 | 4-91 | MR2004S | 4-87 | | | | | | | MZ938B | |
| MR804 | 4-91 | MR2006S | 4-87 | | | | | | | MZ941 | |
| MR806 | 4-91 | MR2008S | 4-87 | | | | | | | MZ941A | |
| MR810 | 4-91 | MR2010S | 4-87 | | | | | | | MZ941B | |
| MR811 | 4-91 | MR7083HA | 4-87 | | | | | | | MZ942 | |
| MR812 | 4-91 | MR7266 | 4-87 | | | | | | | MZ942A | |
| MR813 | | MR7271 | 4-87 | | | | | | | MZ942B | |
| MR814 | 4-91 | MR7272 | 4-87 | | | | | | | MZ943 | |
| MR816 | 4-91 | MR7273 | 4-87 | | | | | | | MZ943A | |
| MR817 | 4-91 | MR7500 | 4-87 | | | | | | | MZ943B | |
| MR818 | 4-91 | MR7501 | 4-87 | | | | | | | MZ944 | |
| MR870 | 4-91 | MR7502 | 4-87 | | | | | | | MZ944A | |
| MR821 | 4-91 | MR7504 | 4-87 | | | | | | | MZ944B | |
| MR822 | 4-91 | MR7506 | 4-87 | | | | | | | MZ944C | |
| MR874 | 4-91 | MR7508 | 4-87 | | | | | | | MZ944D | |
| MR826 | 4-91 | MR7510 | 4-87 | | | | | | | MZ944E | |
| MR830 | 4-91 | MR7500S | 4-87 | | | | | | | MZ944F | |
| MR831 | 4-91 | MR7501S | 4-87 | | | | | | | MZ944G | |
| MR832 | 4-91 | MR7502S | 4-87 | | | | | | | MZ944H | |
| MR834 | 4-91 | MR7504S | 4-87 | | | | | | | MZ944I | |
| MR836 | 4-91 | MR7506S | 4-87 | | | | | | | MZ944J | |
| MR840 | | MR7508S | 4-87 | | | | | | | MZ944K | |
| MR841 | | MR7510S | 4-87 | | | | | | | MZ944L | |
| MR842 | | MR7515 | 4-83 | | | | | | | MZ944M | |
| MR844 | | MR7525R | 4-83 | | | | | | | MZ944N | |
| MR846 | | MR4933 | | | | | | | | MZ944O | |
| MR850 | 4-91 | MR4934 | | | | | | | | MZ944P | |
| MR851 | 4-91 | MR4935 | | | | | | | | MZ944Q | |
| MR852 | 4-91 | MR4936 | | | | | | | | MZ944R | |
| MR854 | 4-91 | MR4937 | | | | | | | | MZ944S | |
| MR856 | 4-91 | MR5005 | 4-87 | | | | | | | MZ944T | |
| MR860 | 4-91 | MR5010 | | | | | | | | MZ944U | |
| MR861 | 4-91 | MR5070 | | | | | | | | MZ944V | |
| MR862 | 4-91 | MR5030 | | | | | | | | MZ944W | |
| MR864 | 4-91 | MR5040 | 4-87 | | | | | | | MZ944X | |
| MR866 | 4-91 | MR1133 | 4-90 | | | | | | | MZ944Y | |
| MR870 | 4-91 | MR1133B | 4-90 | | | | | | | MZ944Z | |
| MR871 | 4-91 | MR1163 | 4-90 | | | | | | | MZ945 | |
| MR872 | 4-91 | MR1163B | 4-90 | | | | | | | MZ945A | |
| MR874 | 4-91 | MR1163B | 4-90 | | | | | | | MZ945B | |
| MR876 | 4-91 | MR1163B | 4-90 | | | | | | | MZ945C | |
| MR890 | | MR1163B | 4-90 | | | | | | | MZ945D | |
| MR891 | | MR1163B | 4-90 | | | | | | | MZ945E | |
| MR892 | | MR1163B | 4-90 | | | | | | | MZ945F | |
| MR894 | | MR1163B | 4-90 | | | | | | | MZ945G | |
| MR896 | | MR1163B | 4-90 | | | | | | | MZ945H | |
| MR910 | 4-91 | MR1163B | 4-90 | | | | | | | MZ945I | |
| MR911 | 4-91 | MR1163B | 4-90 | | | | | | | MZ945J | |
| MR912 | 4-91 | MR1163B | 4-90 | | | | | | | MZ945K | |
| MR914 | 4-91 | MR1163B | 4-90 | | | | | | | MZ945L | |
| MR916 | 4-91 | MR1163B | 4-90 | | | | | | | MZ945M | |
| MR917 | 4-91 | MR1163B | 4-90 | | | | | | | MZ945N | |
| MR918 | 4-91 | MR1163B | 4-90 | | | | | | | MZ945O | |
| MR1120 | 4-87 | MR1163B | 4-90 | | | | | | | MZ945P | |
| MR1121 | 4-87 | MR1163B | 4-90 | | | | | | | MZ945Q | |
| MR1122 | 4-87 | MR1163B | 4-90 | | | | | | | MZ945R | |
| MR1123 | 4-87 | MR1163B | 4-90 | | | | | | | MZ945S | |
| MR1124 | 4-87 | MR1163B | 4-90 | | | | | | | MZ945T | |
| MR1125 | 4-87 | MR1163B | 4-90 | | | | | | | MZ945U | |
| MR1126 | 4-87 | MR1163B | 4-90 | | | | | | | MZ945V | |
| MR1128 | 4-87 | MR1163B | 4-90 | | | | | | | MZ945W | |
| | | | | | | | | | | MZ945X | |
| | | | | | | | | | | MZ945Y | |
| | | | | | | | | | | MZ945Z | |
| | | | | | | | | | | MZ946 | |
| | | | | | | | | | | MZ946A | |
| | | | | | | | | | | MZ946B | |
| | | | | | | | | | | MZ946C | |
| | | | | | | | | | | MZ946D | |
| | | | | | | | | | | MZ946E | |
| | | | | | | | | | | MZ946F | |
| | | | | | | | | | | MZ946G | |
| | | | | | | | | | | MZ946H | |
| | | | | | | | | | | MZ946I | |
| | | | | | | | | | | MZ946J | |
| | | | | | | | | | | MZ946K | |
| | | | | | | | | | | MZ946L | |
| | | | | | | | | | | MZ946M | |
| | | | | | | | | | | MZ946N | |
| | | | | | | | | | | MZ946O | |
| | | | | | | | | | | MZ946P | |
| | | | | | | | | | | MZ946Q | |
| | | | | | | | | | | MZ946R | |
| | | | | | | | | | | MZ946S | |
| | | | | | | | | | | MZ946T | |
| | | | | | | | | | | MZ946U | |
| | | | | | | | | | | MZ946V | |
| | | | | | | | | | | MZ946W | |
| | | | | | | | | | | MZ946X | |
| | | | | | | | | | | MZ946Y | |
| | | | | | | | | | | MZ946Z | |
| | | | | | | | | | | MZ947 | |
| | | | | | | | | | | MZ947A | |
| | | | | | | | | | | MZ947B | |
| | | | | | | | | | | MZ947C | |
| | | | | | | | | | | MZ947D | |
| | | | | | | | | | | MZ947E | |
| | | | | | | | | | | MZ947F | |
| | | | | | | | | | | MZ947G | |
| | | | | | | | | | | MZ947H | |
| | | | | | | | | | | MZ947I | |
| | | | | | | | | | | MZ947J | |
| | | | | | | | | | | MZ947K | |
| | | | | | | | | | | MZ947L | |
| | | | | | | | | | | MZ947M | |
| | | | | | | | | | | MZ947N | |
| | | | | | | | | | | MZ947O | |
| | | | | | | | | | | MZ947P | |
| | | | | | | | | | | MZ947Q | |
| | | | | | | | | | | MZ947R | |
| | | | | | | | | | | MZ947S | |
| | | | | | | | | | | MZ947T | |
| | | | | | | | | | | MZ947U | |
| | | | | | | | | | | MZ947V | |
| | | | | | | | | | | MZ947W | |
| | | | | | | | | | | MZ947X | |
| | | | | | | | | | | MZ947Y | |
| | | | | | | | | | | MZ947Z | |
| | | | | | | | | | | MZ948 | |
| | | | | | | | | | | MZ948A | |
| | | | | | | | | | | MZ948B | |
| | | | | | | | | | | MZ948C | |
| | | | | | | | | | | MZ948D | |
| | | | | | | | | | | MZ948E | |
| | | | | | | | | | | MZ948F | |
| | | | | | | | | | | MZ948G | |
| | | | | | | | | | | MZ948H | |
| | | | | | | | | | | MZ948I | |
| | | | | | | | | | | MZ948J | |
| | | | | | | | | | | MZ948K | |
| | | | | | | | | | | MZ948L | |
| | | | | | | | | | | MZ948M | |
| | | | | | | | | | | MZ948N | |
| | | | | | | | | | | MZ948O | |
| | | | | | | | | | | MZ948P | |
| | | | | | | | | | | MZ948Q | |
| | | | | | | | | | | MZ948R | |
| | | | | | | | | | | MZ948S | |
| | | | | | | | | | | MZ948T | |
| | | | | | | | | | | MZ948U | |
| | | | | | | | | | | MZ948V | |
| | | | | | | | | | | MZ948W | |
| | | | | | | | | | | MZ948X | |
| | | | | | | | | | | MZ948Y | |
| | | | | | | | | | | MZ948Z | |
| | | | | | | | | | | MZ949 | |
| | | | | | | | | | | MZ949A | |
| | | | | | | | | | | M | |

CATALOG INDEX (continued)

| DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE | DEVICE | PAGE |
|--------|------|--------------------|------|-----------|------|-----------|------|----------|------|----------------|------|
| MZ4701 | | Zener Chips | | MZC20A10 | 4-77 | MZC160A10 | 4-77 | MZC11810 | 4-77 | MZC100B10 | 4-77 |
| MZ4702 | | MZC2.4A10 | 4-77 | MZC22A10 | 4-77 | MZC170A10 | 4-77 | MZC12610 | 4-77 | MZC110B10 | 4-77 |
| MZ4703 | | MZC2.7A10 | 4-77 | MZC24A10 | 4-77 | MZC180A10 | 4-77 | MZC13610 | 4-77 | MZC120B10 | 4-77 |
| MZ4704 | | MZC3.0A10 | 4-77 | MZC27A10 | 4-77 | MZC200A10 | 4-77 | MZC15610 | 4-77 | MZC130B10 | 4-77 |
| MZ4705 | | MZC3.3A10 | 4-77 | MZC30A10 | 4-77 | MZC13810 | 4-77 | MZC16610 | 4-77 | MZC140B10 | 4-77 |
| MZ4706 | | MZC3.6A10 | 4-77 | MZC33A10 | 4-77 | MZC2.0B10 | 4-77 | MZC18610 | 4-77 | MZC150B10 | 4-77 |
| MZ4707 | | MZC3.9A10 | 4-77 | MZC36A10 | 4-77 | MZC2.2B10 | 4-77 | MZC20610 | 4-77 | MZC160B10 | 4-77 |
| MZ4708 | | MZC4.3A10 | 4-77 | MZC39A10 | 4-77 | MZC2.4B10 | 4-77 | MZC22610 | 4-77 | MZC170B10 | 4-77 |
| MZ4709 | | MZC4.7A10 | 4-77 | MZC43A10 | 4-77 | MZC2.7B10 | 4-77 | MZC24610 | 4-77 | MZC180B10 | 4-77 |
| MZ4710 | | MZC5.1A10 | 4-77 | MZC47A10 | 4-77 | MZC3.0B10 | 4-77 | MZC27610 | 4-77 | | |
| MZ4711 | | MZC5.6A10 | 4-77 | MZC51A10 | 4-77 | MZC3.3B10 | 4-77 | MZC30610 | 4-77 | 4-Layer | |
| MZ4712 | | MZC6.2A10 | 4-77 | MZC56A10 | 4-77 | MZC3.6B10 | 4-77 | MZC33610 | 4-77 | M413052 | |
| MZ4713 | | MZC6.8A10 | 4-77 | MZC62A10 | 4-77 | MZC3.9B10 | 4-77 | MZC36610 | 4-77 | M413053 | |
| MZ4714 | | MZC7.5A10 | 4-77 | MZC68A10 | 4-77 | MZC4.3B10 | 4-77 | MZC39610 | 4-77 | M413054 | |
| MZ4715 | | MZC8.2A10 | 4-77 | MZC75A10 | 4-77 | MZC4.7B10 | 4-77 | MZC43B10 | 4-77 | MTTL | |
| MZ4716 | | MZC9.1A10 | 4-77 | MZC82A10 | 4-77 | MZC5.1B10 | 4-77 | MZC47B10 | 4-77 | XC117 | 2-15 |
| MZ4717 | | MZC10A10 | 4-77 | MZC91A10 | 4-77 | MZC5.6B10 | 4-77 | MZC51B10 | 4-77 | | |
| MZ5555 | 4-83 | MZC11A10 | 4-77 | MZC100A10 | 4-77 | MZC6.2B10 | 4-77 | MZC56B10 | 4-77 | LINEAR | |
| MZ5556 | 4-83 | MZC12A10 | 4-77 | MZC110A10 | 4-77 | MZC6.8B10 | 4-77 | MZC62B10 | 4-77 | XC1302 | 3-24 |
| MZ5557 | 4-83 | MZC13A10 | 4-77 | MZC120A10 | 4-77 | MZC7.5B10 | 4-77 | MZC68B10 | 4-77 | XC1387 | 3-23 |
| MZ5558 | 4-83 | MZC15A10 | 4-77 | MZC130A10 | 4-77 | MZC8.2B10 | 4-77 | MZC75B10 | 4-77 | XC1389 | 3-23 |
| | | MZC16A10 | 4-77 | MZC140A10 | 4-77 | MZC9.1B10 | 4-77 | MZC82B10 | 4-77 | XC1393 | |
| | | MZC18A10 | 4-77 | MZC150A10 | 4-77 | MZC10B10 | 4-77 | MZC91B10 | 4-77 | XC1399 | 3-22 |

POPULAR PRO-ELECTRON DEVICE TYPES

Index

| | Page |
|--|------|
| SMALL SIGNAL TRANSISTORS _____ TO-92 | 1 |
| SMALL SIGNAL TRANSISTORS _____ TO-5, TO-18, TO-39 | 7 |
| POWER TRANSISTORS _____ CASE 77, 90, TO-3, TO-39 (UNIWATT, OUOWATT) | 8 |
| RF TRANSISTORS _____ SOT-2, TO-72 (SEE ALSO TO-92 TYPES) | 11 |
| ZENER DIODES _____ | 11 |
| RECTIFIERS PRDDUCTS _____ | 12 |
| SPECIAL PURPOSE DIOOES _____ | 13 |
| LINEAR INTEGRATED CIRCUITS _____ | 14 |

SMALL SIGNAL PLASTIC TRANSISTORS: TO-92

SMALL SIGNAL PLASTIC TRANSISTORS represent MOTOROLA's broadest product line of any package. The TO-92, from R.F./V.H.F./U.H.F. amplifiers, mixers, oscillators and switches to general purpose amplifiers and switches are all available as standard product or custom specials. Also available are special devices for the Industrial, Computer or Consumer Markets.

Before you finalize your next circuit design, consider MOTOROLA's TO-92 Plastic transistors for every possible socket. The following Cross Reference gives you an alphanumeric list of all pro-electron small signal devices, their suggested replacement and the number of the selection table in which the device is further characterized.

GENERAL PURPOSE AMPLIFIER TRANSISTORS - TO 92. TABLE 1

The general purpose transistors are designed for small signal amplification from d.c. to low radio frequencies. They are also useful as oscillators and general purpose switches.

| NPN | PNP | BV _{CEO} Volts | P _{DMW} | I _{Cmax} mA cont. | h _{FE} | | I _C (mA) | V _{CE} (V) | f _T typ MHz | NF max dB | Pin out |
|----------|----------|----------------------------|------------------|----------------------------------|-----------------|-----|------------------------|------------------------|------------------------------|-----------------|------------|
| | | | | | min | max | | | | | |
| BC182 | BC212 | 50 | 625 | 100 | 120 | 460 | 2.0 | 5.0 | 200 | 10 | CBE |
| BC182A | BC212A | 50 | 625 | 100 | 120 | 220 | 2.0 | 5.0 | 200 | 10 | " |
| BC182B | BC212B | 50 | 625 | 100 | 180 | 460 | 2.0 | 5.0 | 200 | 10 | " |
| BC237 | BC307 | 45 | 625 | 100 | 120 | 460 | 2.0 | 5.0 | 200 | 10 | " |
| BC237A | BC307A | 45 | 625 | 100 | 120 | 220 | 2.0 | 5.0 | 200 | 10 | " |
| BC237B | BC307B | 45 | 625 | 100 | 180 | 460 | 2.0 | 5.0 | 200 | 10 | " |
| BC237C | BC307C | 45 | 625 | 100 | 380 | 800 | 2.0 | 5.0 | 200 | 10 | " |
| BC238 | BC308 | 25 | 625 | 100 | 120 | 800 | 2.0 | 5.0 | 200 | 10 | " |
| BC238A | BC308A | 25 | 625 | 100 | 120 | 220 | 2.0 | 5.0 | 200 | 10 | " |
| BC238B | BC308B | 25 | 625 | 100 | 180 | 460 | 2.0 | 5.0 | 200 | 10 | " |
| BC238C | BC308C | 25 | 625 | 100 | 380 | 800 | 2.0 | 5.0 | 200 | 10 | " |
| BC239 | BC309 | 45 | 625 | 180 | 180 | 800 | 2.0 | 5.0 | 240 | 4 | " |
| BC239A | BC309A | 45 | 625 | 100 | 120 | 220 | 2.0 | 5.0 | 240 | 4 | " |
| BC239B | BC309B | 45 | 625 | 100 | 180 | 460 | 2.0 | 5.0 | 240 | 4 | " |
| BC239C | BC309C | 45 | 625 | 100 | 380 | 800 | 2.0 | 5.0 | 240 | 4 | " |
| * BC347 | * BC350 | 45 | 625 | 100 | 40 | 450 | 2.0 | 5.0 | 200 | 8 | E8C |
| * BC347A | * BC350A | 45 | 625 | 100 | 110 | 220 | 2.0 | 5.0 | 200 | 8 | " |
| * BC347B | * BC350B | 45 | 625 | 100 | 200 | 450 | 2.0 | 5.0 | 200 | 8 | " |
| * BC348 | * BC351 | 30 | 625 | 100 | 40 | 450 | 2.0 | 5.0 | 200 | 8 | " |
| * BC348A | * BC351A | 30 | 625 | 100 | 110 | 220 | 2.0 | 5.0 | 200 | 8 | " |
| * BC348B | * BC351B | 30 | 625 | 100 | 200 | 450 | 2.0 | 5.0 | 200 | 8 | " |
| * BC349 | * BC352 | 20 | 625 | 100 | 40 | 450 | 2.0 | 5.0 | 240 | 8 | " |
| * BC349A | * BC352A | 20 | 625 | 100 | 110 | 220 | 2.0 | 5.0 | 240 | 8 | " |
| * BC349B | * BC352B | 20 | 625 | 100 | 200 | 450 | 2.0 | 5.0 | 240 | 8 | " |
| BC546 | BC556 | 65 | 625 | 100 | 120 | 450 | 2.0 | 5.0 | 300 | 10 | CBE |
| BC546A | BC556A | 65 | 625 | 100 | 120 | 220 | 2.0 | 5.0 | 300 | 10 | " |
| BC546B | BC556B | 65 | 625 | 100 | 180 | 450 | 2.0 | 5.0 | 300 | 10 | " |
| 8C547 | 8C557 | 45 | 625 | 100 | 120 | 450 | 2.0 | 5.0 | 300 | 10 | " |
| BC547A | BC557A | 45 | 625 | 100 | 120 | 220 | 2.0 | 5.0 | 300 | 10 | " |
| BC547B | BC557B | 45 | 625 | 100 | 180 | 450 | 2.0 | 5.0 | 300 | 10 | " |
| BC547C | BC557C | 45 | 625 | 100 | 380 | 800 | 2.0 | 5.0 | 300 | 10 | " |
| BC548 | BC558 | 30 | 625 | 100 | 120 | 800 | 2.0 | 5.0 | 300 | 10 | " |
| BC548A | BC558A | 30 | 625 | 100 | 120 | 220 | 2.0 | 5.0 | 300 | 10 | " |
| BC548B | BC558B | 30 | 625 | 100 | 180 | 450 | 2.0 | 5.0 | 300 | 10 | " |
| BC548C | BC558C | 30 | 625 | 100 | 380 | 800 | 2.0 | 5.0 | 300 | 10 | " |

* NOT FOR NEW DESIGN

LOW NOISE AND GOOD H_{FE} LINEARITY. TABLE 2

These devices are designed to use on applications where good H_{FE} linearity and low noise characteristics are required: instrumentation, HiFi preamplifier.

| NPN | PNP | V_{CE0} Volts | P_{DmW} 25°C Amb | H_{FE} 10 $\mu A/5V$ | | H_{FE} 2mA/5V | | (1) V_t 120 Hz mV | | (2) NF db | | FT typ MHz |
|--------|--------|--------------------|--------------------------|---------------------------|-----|--------------------|------|---------------------------|-----|-----------------|-----|------------------|
| | | | | min. | typ | min. | max. | typ | max | typ | max | |
| BC239 | BC309 | 45 | 625 | — | — | 120 | 800 | 9.5 | — | 2 | 4 | 240 |
| BC239A | BC309A | 45 | 625 | — | 90 | 120 | 220 | 9.5 | — | 2 | 4 | 240 |
| BC239B | BC309B | 45 | 625 | — | 150 | 180 | 460 | 9.5 | — | 2 | 4 | 240 |
| BC239C | BC309C | 45 | 625 | — | 270 | 380 | 800 | 9.5 | — | 2 | 4 | 240 |
| BC413 | BC415 | 30 | 625 | 100 | — | 180 | 800 | 8 | 12 | 0.6 | 2.5 | 250 |
| BC413B | BC415B | 30 | 625 | 100 | 150 | 180 | 460 | 8 | 12 | 0.6 | 2.5 | 250 |
| BC413C | BC415C | 30 | 625 | 100 | 270 | 380 | 800 | 8 | 12 | 0.6 | 2.5 | 250 |
| BC414 | BC416 | 45 | 625 | 100 | — | 180 | 800 | 8 | 12 | 0.6 | 2.5 | 250 |
| BC414B | BC416B | 45 | 625 | 100 | 150 | 180 | 460 | 8 | 12 | 0.6 | 2.5 | 250 |
| BC414C | BC416C | 45 | 625 | 100 | 270 | 380 | 800 | 8 | 12 | 0.6 | 2.5 | 250 |
| BC549 | BC559 | 30 | 625 | 100 | — | 180 | 800 | 8 | 12 | 0.6 | 2.5 | 250 |
| BC549B | BC559B | 30 | 625 | 100 | 150 | 180 | 460 | 8 | 12 | 0.6 | 2.5 | 250 |
| BC549C | BC559C | 30 | 625 | 100 | 270 | 380 | 800 | 8 | 12 | 0.6 | 2.5 | 250 |
| BC550 | BC560 | 45 | 625 | 100 | — | 180 | 800 | 8 | 12 | 0.6 | 2.5 | 250 |
| BC550B | BC560B | 45 | 625 | 100 | 150 | 180 | 460 | 8 | 12 | 0.6 | 2.5 | 250 |
| BC550C | BC560C | 45 | 625 | 100 | 270 | 380 | 800 | 8 | 12 | 0.6 | 2.5 | 250 |
| MPSA1B | | 45 | 625 | 400 | 500 | 500 | — | 7 | — | — | 1.5 | 160 |

(1) V_t : total input noise voltage (see application note on BC 413/BC414 and BC415/BC416 data sheet), at $R_s = 2 K\Omega$, $I_C = 200 \mu A$, $V_{CE} = 5 V$

(2) NF: noise figure at $R_s = 2 K\Omega$, $I_C = 200 \mu A$, $V_{CE} = 5 V$ and $F = 30 Hz$ to $15 KHz$.

HIGH CURRENT AMPLIFIER TRANSISTORS – TO 92 TABLE 3

Useful in low power audio output stages and medium current switches.

| NPN | PNP | BV _{CEO} Volts min | P _D mW T _A =25°C | I _C max m.A. cont. | h _{FE} | | I _C (mA) | V _{CE} (V) | f _H typ MHz |
|----------|----------|-----------------------------------|---|-------------------------------------|-----------------|-----|------------------------|------------------------|------------------------------|
| | | | | | min | max | | | |
| BC337 | BC327 | 45 | 625 | 800 | 100 | 600 | 100 | 1 | 210 |
| 8C337-16 | BC237-16 | 45 | 625 | 800 | 100 | 250 | 100 | 1 | 210 |
| BC337-25 | BC327-25 | 45 | 625 | 800 | 160 | 400 | 100 | 1 | 210 |
| BC337-40 | | 45 | 625 | 800 | 250 | 600 | 100 | 1 | 210 |
| BC338 | BC328 | 25 | 625 | 800 | 100 | 600 | 100 | 1 | 210 |
| 8C338-16 | BC328-16 | 25 | 625 | 800 | 100 | 250 | 100 | 1 | 210 |
| BC338-25 | BC328-25 | 25 | 625 | 800 | 160 | 400 | 100 | 1 | 210 |
| BC338-40 | | 25 | 625 | 800 | 250 | 600 | 100 | 1 | 210 |
| BC445 | BC446 | 60 | 625 | 200 | 70 | — | 10 | 5 | 250/200(1) |
| BC447 | BC448 | 80 | 625 | 200 | 70 | — | 10 | 5 | 250/200(1) |
| BC449 | BC450 | 100 | 625 | 200 | 70 | — | 10 | 5 | 250/200(1) |
| BC485 | BC486 | 45 | 625 | 1000 | 60 | 400 | 100 | 2 | 200/150(1) |
| BC485L | BC486L | 45 | 625 | 1000 | 60 | 150 | 100 | 2 | 200/150(1) |
| BC485A | BC486A | 45 | 625 | 1000 | 100 | 250 | 100 | 2 | 200/160(1) |
| BC485B | BC486B | 45 | 625 | 1000 | 160 | 400 | 100 | 2 | 200/150(1) |
| BC487 | BC488 | 60 | 625 | 1000 | 60 | 400 | 100 | 2 | 200/150(1) |
| BC487L | BC488L | 60 | 625 | 1000 | 60 | 150 | 100 | 2 | 200/150(1) |
| BC487A | BC488A | 60 | 625 | 1000 | 100 | 250 | 100 | 2 | 200/150(1) |
| 8C487B | BC488B | 60 | 625 | 1000 | 160 | 400 | 100 | 2 | 200/150(1) |
| BC489 | BC490 | 80 | 625 | 1000 | 60 | 400 | 100 | 2 | 200/150(1) |
| BC489L | BC490L | 80 | 625 | 1000 | 60 | 150 | 100 | 2 | 200/150(1) |
| BC489A | BC490A | 80 | 625 | 1000 | 100 | 250 | 100 | 2 | 200/150(1) |
| BC489B | BC490B | 80 | 625 | 1000 | 160 | 400 | 100 | 2 | 200/150(1) |
| MP5A05 | MP5A55 | 60 | 625 | 500 | 50 | — | 100 | 1 | 150/175(1) |
| MP5A06 | MP5A56 | 80 | 625 | 500 | 50 | — | 100 | 1 | 150/175(1) |

(1) PNP TYP

MP5A05/06 pinning order EBC
All others CBE

HIGH VOLTAGE AMPLIFIER TRANSISTORS – TO 92 – TABLE 4

| NPN | PNP | BV _{CEO} Volts | P _D max T _A =25°C | I _C max mA cont. | h _{FE} | | C _{re} P _f typ | f _T | | typ | Pinning |
|--------|--------|----------------------------|--|-----------------------------------|-----------------|---|--|------------------------|------------------------|-----|---------|
| | | | | | min | V _{CE} I _C (mA) (V) | | I _C (mA) | V _{CE} (V) | | |
| MP5L01 | 2N5400 | 120 | 625 | 600 | 50 | 10 5 | 3 | 10 | 10 | 160 | EBC |
| 2N5550 | — | 140 | 625 | 600 | 60 | 10 5 | 3 | 10 | 10 | 160 | EBC |
| 2N5551 | — | 160 | 625 | 600 | 80 | 10 5 | 3 | 10 | 10 | 200 | EBC |
| | 2N5401 | 150 | 625 | 600 | 60 | 10 5 | 4 | 10 | 10 | 150 | EBC |
| BF391 | MP5A93 | 200 | 625 | 500 | 40 | 10 10 | 1.6 | 10 | 60 | 70 | EBC |
| BF392 | — | 250 | 625 | 500 | 40 | 10 10 | 1.6 | 10 | 60 | 70 | EBC |
| BF393 | — | 300 | 625 | 500 | 40 | 10 10 | 1.6 | 10 | 60 | 70 | EBC |

All pinning order EBC

INDUSTRIAL TRANSISTORS TO 92 TABLE 5

These devices are special products range in tended for use in applications which required well specified performing devices like high quality amplifiers, differential input, driver stages

| NPN | PNP | BV _{CEO} VOLTS | P _D mW T _A =25°C | I _C max mA | h _{FE} | | I _C (mA) | V _{CE} (V) | f _T typ MHz | NF typ dB | t _{on} typ ns | t _{off} typ ns |
|----------|----------|----------------------------|---|--------------------------|-----------------|-----|------------------------|------------------------|---------------------------|-----------------|------------------------------|-------------------------------|
| | | | | | min | max | | | | | | |
| BCX25 | BCX26 | 60 | 625 | 200 | 70 | 400 | 10 | 5 | 250 | 2 | 70 | 1000/600 |
| BCX27 | BCX28 | 80 | 625 | 200 | 70 | 400 | 10 | 5 | 250 | 2 | 70 | 1000/600 |
| BCX29 | BCX30 | 100 | 625 | 200 | 70 | 400 | 10 | 5 | 250 | 2 | 70 | 1000/600 |
| BCX45 | BCX46 | 45 | 625 | 1000 | 50 | — | 100 | 2 | 150 | 2 | 30 | 380 |
| BCX47 | BCX48 | 60 | 625 | 1000 | 50 | — | 100 | 2 | 150 | 2 | 30 | 380 |
| BCX49 | BCX50 | 80 | 625 | 1000 | 50 | — | 100 | 2 | 150 | 2 | 30 | 380 |
| BCX58 | BCX78 | 32 | 625 | 200 | 120 | 630 | 2 | 5 | 250 | 2 | 75 | 600/350 |
| BCX58-7 | BCX78-7 | 32 | 625 | 200 | 120 | 220 | 2 | 5 | 250 | 2 | 75 | 600/350 |
| BCX58-8 | BCX78-8 | 32 | 625 | 200 | 180 | 310 | 2 | 5 | 250 | 2 | 75 | 600/350 |
| BCX58-9 | BCX78-9 | 32 | 625 | 200 | 250 | 460 | 2 | 5 | 250 | 2 | 75 | 600/350 |
| BCX58-10 | BCX78-10 | 32 | 625 | 200 | 380 | 630 | 2 | 5 | 250 | 2 | 75 | 600/350 |
| BCX59 | BCX79 | 45 | 625 | 200 | 120 | 630 | 2 | 5 | 250 | 2 | 75 | 600/350 |
| BCX59-7 | BCX79-7 | 45 | 625 | 200 | 120 | 220 | 2 | 5 | 250 | 2 | 75 | 600/350 |
| BCX59-B | BCX79-B | 45 | 625 | 200 | 180 | 310 | 2 | 5 | 250 | 2 | 75 | 600/350 |
| BCX59-9 | BCX79-9 | 45 | 625 | 200 | 250 | 460 | 2 | 5 | 250 | 2 | 75 | 600/350 |
| BCX59-10 | BCX79-10 | 45 | 625 | 200 | 380 | 630 | 2 | 5 | 250 | 2 | 75 | 600/350 |
| BCX73 | BCX75 | 32 | 625 | 800 | 100 | 630 | 100 | 1 | 210 | 2 | 30 | 250 |
| BCX73-16 | BCX75-16 | 32 | 625 | 800 | 100 | 250 | 100 | 1 | 210 | 2 | 30 | 250 |
| BCX73-25 | BCX75-25 | 32 | 625 | 800 | 160 | 400 | 100 | 1 | 210 | 2 | 30 | 250 |
| BCX73-40 | — | 32 | 625 | 800 | 250 | 630 | 100 | 1 | 210 | 2 | 30 | 250 |
| BCX74 | BCX76 | 45 | 625 | 800 | 100 | 630 | 100 | 1 | 210 | 2 | 30 | 250 |
| BCX74-16 | BCX76-16 | 45 | 625 | 800 | 100 | 250 | 100 | 1 | 210 | 2 | 30 | 250 |
| BCX74-25 | BCX76-25 | 45 | 625 | 800 | 160 | 400 | 100 | 1 | 210 | 2 | 30 | 250 |
| BCX74-40 | — | 45 | 625 | 800 | 250 | 630 | 100 | 1 | 210 | 2 | 30 | 250 |

All pinning order CBE

RF TRANSISTORS TO 92 TABLE 6

The RF transistors are designed for small signal amplification from RF to UHF — several are also used as mixer and oscillator in the same range at frequencies type are AGC characterised.

| AM/FM/IF | | PIN OUT | V _{CE} min | P _D max mW | I _C max mA | h _{FE} min | I _C mA | V _{CE} Volt | f _T min MHz | C _{re} C _{rb} pF | Cob pF | PG typ dB | NF dB | f MHz |
|----------|---------|------------|------------------------|-----------------------------|-----------------------------|------------------------|----------------------|-------------------------|---------------------------|--|-----------|-----------------|----------|----------|
| NPN | PNP | | | | | | | | | | | | | |
| BF198 + | | CEB | 30 | 625 | 25 | 27 | 4 | 10 | 800* | 2* | | | 3.0* | 35 |
| BF199 | | CEB | 25 | 625 | 100 | 40 | 7 | 10 | 750* | .2B* | | | | |
| BF254 | | CEB | 20 | 625 | 100 | 65 | 1 | 10 | 260* | .95* | | | 1.7* | 1 |
| BF241 | | CEB | 40 | 625 | 25 | 35 | 1 | 10 | 400 | .34 | | | | |
| BF254-3 | | CEB | 20 | 625 | 100 | 65 | 1 | 10 | 260* | .95* | | | 1.7* | 1 |
| BF254-4 | | CEB | 20 | 625 | 100 | 100 | 1 | 10 | 260* | .95* | | | 1.7* | 1 |
| BF255 | | CEB | 20 | 625 | 100 | 35 | 1 | 10 | 200* | .95* | | | 1.7* | 1 |
| BF255-2 | | CEB | 20 | 625 | 100 | 35 | 1 | 10 | 200* | .95* | | | 1.7* | 1 |
| BF255-3 | | CEB | 20 | 625 | 100 | 65 | 1 | 10 | 200* | .95 | | | 1.7* | 1 |
| BF368 | | EBC | 15 | 625 | 50 | 35 | 1 | 10 | 250 | .95* | 1.7 | | 4.0 | 100 |
| BF369 | | EBC | 20 | 625 | 50 | 70 | 1 | 10 | 400 | .95* | 1.7 | | 4.0 | 100 |
| BF371 | | BEC | 30 | 625 | 100 | 40 | 1 | 10 | 500 | .23* | | | | |
| BF373 | | BEC | 45 | 625 | 100 | 40 | 1 | 10 | 720* | .32 | | | | |
| BF394• | | BEC | 30 | 625 | 100 | 65 | 1 | 0 | 80 | .9* | | | 1.7* | 1 |
| BF394B• | | BEC | 30 | 625 | 100 | 100 | 1 | 10 | 80 | .9* | | | 1.7* | 1 |
| BF395• | | BEC | 30 | 625 | 100 | 35 | 1 | 10 | 80 | .9* | | | 1.7* | 1 |
| BF395D• | | BEC | 30 | 625 | 100 | 35 | 1 | 10 | 80 | .9* | | | 1.7* | 1 |
| BF395C• | | BEC | 30 | 625 | 100 | 65 | 1 | 10 | 80 | .9* | | | 1.7* | 1 |
| MPS918 | | EBC | 15 | 625 | 100 | 20 | 3.0 | 10 | 600 | | 1.7 | 15 | 6.0 | 60 |
| MPSH05 | | EBC | 80 | 625 | 100 | 30 | 1.5 | 10 | 180* | 1.6 | | | 1.7 | 1 |
| | MPSH54 | EBC | 80 | 625 | 100 | 30 | 1.5 | 10 | 185* | 1.6 | | | 2.0 | 1 |
| V.H.F. | | | | | | | | | | | | | | |
| BF366 | | EBC | 25 | 625 | 25 | 75 | 3 | 10 | 400 | .3 | | 30 | 3.2 | 100 |
| BF374 | | BEC | 25 | 625 | 100 | 70 | | | 800 | 6 | | 20 | 4.0* | 100 |
| BF375 | | BEC | 25 | 625 | 100 | 35 | | | 800 | 6 | | 20 | 4.0* | 100 |
| BF375C | | BEC | 25 | 625 | 100 | 70 | | | 800 | 6 | | 20 | 4.0* | 100 |
| BF375D | | BEC | 25 | 625 | 100 | 35 | 1 | 10 | 800 | 6 | | 20 | 4.0* | 100 |
| | BF706 | EBC | 25 | 625 | 50 | 20 | 2 | 10 | 700 | .4 | .6* | | | |
| | BF709 | EBC | 30 | 625 | 50 | 20 | 2.5 | 10 | 350 | .3 | | 12 | 3.5* | 200 |
| | BF906 | EBC | 25 | 625 | 50 | 20 | 2 | 10 | 700 | .22* | .6* | | 2.5* | 100 |
| U.H.F. | | | | | | | | | | | | | | |
| | BF739 + | EBC | 30 | 625 | 50 | 20 | 2.5 | 10 | 600 | .3 | | 10 | 4.2* | 850 |
| | BF740 | EBC | 20 | 625 | 50 | 20 | 2 | 10 | 600 | 4 | .6* | | | |
| MPSH33 + | | EBC | 30 | 625 | 100 | 20 | 2.5 | 10 | 950 | .3 | | 10 | 6.5 | 850 |

* Typical

+ A.G.C. Characteristic

• NOT FOR NEW DESIGN

MEDIUM POWER (UNIWATT) TRANSISTORS TABLE 7

For applications requiring higher power dissipation than that of the standard TO-92 package MOTOROLA has developed the Uniwatt case. In this plastic-encapsulated package, which is slightly larger than the small signal case, the collector is mounted on a metal tab that extends out of the case. With a satisfactory heat sink Uniwatt transistors can dissipate up to 10 Watts. Without a heat sink power dissipation at an ambient of 25 °C is 1.0 Watt.

| NPN | PNP | BV _{CEO} Volts min | PD @ 25°C W | | I _C max Amps | h _{FE} | | | V _{CE} Volts | V _{CE} max V | f _T min MHz | COB @ I _C | |
|--------|-------|-----------------------------------|------------------|-------------------|-------------------------------|-----------------|-----|------|--------------------------|--------------------------|------------------------------|----------------------|------|
| | | | T _{amb} | T _{case} | | min | max | Amps | | | | max Pf | Amps |
| BD505 | BD506 | 20 | 1.0 | 10 | 2 | 60 | — | 0.25 | 2 | 0.7 | 50 | 30 | 1.0 |
| BD507 | BD508 | 30 | 1.0 | 10 | 2 | 60 | — | 0.25 | 2 | 0.7 | 50 | 30 | 1.0 |
| BD509 | BD510 | 40 | 1.0 | 10 | 2 | 60 | — | 0.25 | 2 | 0.7 | 50 | 30 | 1.0 |
| BD515 | BD516 | 45 | 1.0 | 10 | 2 | 60 | 350 | 0.15 | 2 | 0.5 | 50 | 12 | 0.5 |
| BD517 | BD518 | 60 | 1.0 | 10 | 2 | 60 | 350 | 0.15 | 2 | 0.5 | 50 | 12 | 0.5 |
| BD519 | BD520 | 80 | 1.0 | 10 | 2 | 60 | 350 | 0.15 | 2 | 0.5 | 50 | 12 | 0.5 |
| BD525 | BD526 | 60 | 1.0 | 10 | 2 | 60 | — | 0.05 | 2 | 0.5 | 50 | 15 | 0.25 |
| BD527 | BD528 | 80 | 1.0 | 10 | 2 | 60 | — | 0.05 | 2 | 0.5 | 50 | 15 | 0.25 |
| BD529 | BD530 | 100 | 1.0 | 10 | 2 | 60 | — | 0.05 | 2 | 0.5 | 50 | 15 | 0.25 |
| BF380 | | 180 | 1.0 | 10 | 0.5 | 25 | — | 0.03 | 10 | 0.75 | 90 | — | 0.03 |
| BF381 | | 250 | 1.0 | 10 | 0.5 | 25 | — | 0.03 | 10 | 0.75 | 90 | — | 0.03 |
| BF382 | | 300 | 1.0 | 10 | 0.5 | 25 | — | 0.03 | 10 | 0.75 | 90 | — | 0.03 |
| MPSU03 | | 120 | 1.0 | 10 | 1.0 | 40 | — | 0.01 | 10 | .5 | 100 | 12 | .05 |
| MPSU04 | | 180 | 1.0 | 10 | 1.0 | 40 | — | 0.01 | 10 | .5 | 100 | 12 | .05 |

DUOWATT TRANSISTORS TABLE 8

This is a new family developed by MOTOROLA for high power dissipation in free air applications. As the uniwatt the collector is mounted on a metal tab extend to the case, without a heat sink power dissipation of the duowatt at an ambient of 25 °C is 2.0 Watts.

| NPN | PNP | BV _{CEO} Volts min | PD @ 25°C W | | I _C max Amps | h _{FE} | | | V _{CE} Volts | V _{CE} max | f _T min MHz | I _C @ | | COB max Pf | Pinning |
|-------|-------|-----------------------------------|------------------|-------------------|-------------------------------|-----------------|------|------|--------------------------|------------------------|------------------------------|------------------|-----------|------------------|---------|
| | | | T _{amb} | T _{case} | | min | max | Amps | | | | Amps | max Pf | | |
| BD385 | BD386 | 60 | 2.0 | 10 | 1.0 | 60 | — | 0.25 | 1.0 | 0.5 | 75 | 100 | 18 | ECB | |
| BD387 | BD388 | 80 | 2.0 | 10 | 1.0 | 60 | — | 0.25 | 1.0 | 0.5 | 75 | 100 | 18 | " | |
| BD389 | BD390 | 100 | 2.0 | 10 | 1.0 | 60 | — | 0.25 | 1.0 | 0.5 | 75 | 100 | 18 | " | |
| BD411 | BD413 | 40 | 2.0 | 10 | 2.0 | 25K | 150K | 0.2 | 5.0 | — | 100 | 200 | 7 | EBC | |
| BD412 | BD414 | 40 | 2.0 | 10 | 2.0 | 15K | 150K | 0.2 | 5.0 | — | 100 | 200 | 7 | | |
| BD415 | BD416 | 60 | 2.0 | 10 | 1.0 | 60 | — | 0.25 | 1.0 | 0.5 | 75 | 100 | 18 | | |
| BD417 | BD418 | 80 | 2.0 | 10 | 1.0 | 60 | — | 0.25 | 1.0 | 0.5 | 75 | 100 | 18 | | |
| BD419 | BD420 | 100 | 2.0 | 10 | 1.0 | 60 | — | 0.25 | 1.0 | 0.5 | 75 | 100 | 18 | | |
| BD421 | — | 100 | 2.0 | 10 | 2.0 | 15K | — | 0.25 | 5.0 | 1.0 | 100 | 200 | 15 | | |
| BD422 | — | 80 | 2.0 | 10 | 2.0 | 15K | — | 0.25 | 5.0 | 1.0 | 100 | 200 | 15 | | |
| BF460 | BD463 | 250 | 2.0 | 10 | 0.5 | 40 | 180 | 0.03 | 10 | 0.6 | 45 | 10 | 3.0 | | |
| BF461 | BD464 | 300 | 2.0 | 10 | 0.5 | 40 | 180 | 0.03 | 10 | 0.6 | 45 | 10 | 3.0 | | |
| BF462 | BF465 | 350 | 2.0 | 10 | 0.5 | 40 | 180 | 0.03 | 10 | 0.6 | 45 | 10 | 3.0 | | |
| BF466 | — | 150 | 2.0 | 10 | 1.0 | 40 | — | 0.1 | 10 | — | 100 | 50 | 12 | | |
| BF467 | — | 200 | 2.0 | 10 | 1.0 | 40 | — | 0.1 | 10 | — | 100 | 50 | 12 | | |
| BF468 | — | 250 | 2.0 | 10 | 1.0 | 40 | — | 0.1 | 10 | — | 100 | 50 | 12 | | |
| BF666 | — | 150 | 2.0 | 10 | 1.0 | 40 | — | 0.1 | 10 | — | 100 | 50 | 12 | FCB | |
| BF667 | — | 200 | 2.0 | 10 | 1.0 | 40 | — | 0.1 | 10 | — | 100 | 50 | 12 | " | |
| BF668 | — | 250 | 2.0 | 10 | 1.0 | 40 | — | 0.1 | 10 | — | 100 | 50 | 12 | " | |
| BF757 | BF760 | 250 | 2.0 | 10 | 0.5 | 40 | 180 | 0.03 | 10 | 0.6 | 45 | 10 | 3.0 | " | |
| BF758 | BF761 | 300 | 2.0 | 10 | 0.5 | 40 | 180 | 0.03 | 10 | 0.6 | 45 | 10 | 3.0 | " | |
| BF759 | BF762 | 350 | 2.0 | 10 | 0.5 | 40 | 180 | 0.03 | 10 | 0.6 | 45 | 10 | 3.0 | " | |

MEDIUM CURRENT AMPLIFIERS & SWITCHES (TO-39)

| DEVICE TYPE | NPN | PNP | V _{CEO} (VDC) | I _C max (mA) | H _{FE} min. AT I _C (mA) | V _{CE} (Volts) | V _{CE} (Sat) max AT I _C (mA) | I _B (mA) | F _T min AT I _C (mA) |
|-------------|-----|-----|------------------------|-------------------------|---|-------------------------|--|---------------------|---|
| BFY50 | NPN | | 35 | 1000 | 30 | 150 | 6 | 0.2 | 150 |
| BFY51 | NPN | | 30 | 1000 | 40 | 150 | 6 | 0.35 | 150 |
| BFY52 | NPN | | 20 | 1000 | 60 | 150 | 6 | 0.35 | 150 |
| BSX45 | NPN | | 40 | 1000 | 40 | 100 | 1 | 1.0 | 1000 |
| BSX46 | NPN | | 60 | 1000 | 40 | 100 | 1 | 1.0 | 1000 |
| BSX47 | NPN | | 80 | 1000 | 40 | 100 | 1 | 0.9 | 500 |
| BFX38 | | PNP | 55 | 1000 | 85 | 100 | 5 | 0.15 | 150 |
| BFX39 | | PNP | 55 | 1000 | 40 | 100 | 5 | 0.15 | 150 |
| BFX40 | | PNP | 75 | 1000 | 85 | 100 | 5 | 0.15 | 150 |
| BFX41 | | PNP | 75 | 1000 | 40 | 100 | 5 | 0.15 | 150 |

VIDEO OUTPUT (TO-39)

| DEVICE TYPE | NPN | V _{CEO} (Volts) | I _C max (mA) | H _{FE} AT I _C (mA) | V _{CE} (Volts) | V _{CE} (Sat) AT I _C (mA) | I _B (mA) | F _T type AT I _C (MHz) | COB max (pF) |
|-------------|-----|--------------------------|-------------------------|--|-------------------------|--|---------------------|---|--------------|
| BF257 | NPN | 180 | 100 | 25 | 30 | 10 | 1 | 30 | 6 |
| BF258 | NPN | 250 | 100 | 25 | 30 | 10 | 1 | 30 | 6 |
| BF259 | NPN | 300 | 100 | 25 | 30 | 10 | 1 | 30 | 6 |

AUDIO DRIVERS (TO-39)

| DEVICE TYPE | NPN | PNP | V _{CEO} (VDC) | I _C max (mA) | H _{FE} AT I _C (mA) | V _{CE} (VDC) | V _{CE} (Sat) (VDC) | I _C (mA) | I _B (mA) | F _T min AT I _C (MHz) |
|-------------|-----|-----|------------------------|-------------------------|--|-----------------------|-----------------------------|---------------------|---------------------|--|
| BC140 | NPN | | 40 | 1000 | 40 | 100 | 1 | 1 | 1000 | 100 |
| BC141 | NPN | | 60 | 1000 | 40 | 100 | 1 | 1 | 1000 | 100 |
| BC160 | | PNP | 40 | 1000 | 40 | 100 | 1 | 1 | 1000 | 100 |
| BC161 | | PNP | 60 | 1000 | 40 | 100 | 1 | 1 | 1000 | 100 |

NOTE: Exists IH -6-10-16
HFE Groups

GENERAL PURPOSE SWITCHING & AMPLIFIER TRANSISTORS (TO-18)

| DEVICE TYPE | PNP | NPN | V _{CEO} [Volts] | I _C max [mA] | HFE min AT I _C [mA] | V _{CE} [Volts] | V _{CE} sat [Volts] | I _C [mA] | I _B [mA] | F _T (MHz) ~typ min | I _C [mA] | COMMENTS | |
|-------------|-----|-----|--------------------------|-------------------------|--------------------------------|-------------------------|-----------------------------|---------------------|---------------------|-------------------------------|---------------------|----------|-------------------------------------|
| BC177 | PNP | | 45 | 100 | 70 | 2 | 5.0 | 0.6 | 100 | 5 | 130 | 10 | EXIST VIA B HFE RANGE |
| BC178 | PNP | | 30 | 100 | 70 | 2 | 5.0 | 0.6 | 100 | 5 | 130 | 10 | |
| BCY77 | PNP | | 60 | 100 | 120 | 2 | 5.0 | 0.8 | 50 | 1.25 | 180 - | 10 | EXIST VII,VIII,IX,A,B, GROUP |
| BCY78 | PNP | | 32 | 200 | 120 | 2 | 5.0 | 0.8 | 100 | 2.5 | 180 - | 10 | EXIST HFE GROUP VII,VIII, IX, X |
| BCY79 | PNP | | 45 | 200 | 120 | 2 | 5.0 | 0.8 | 100 | 2.5 | 180 - | 10 | |
| BSW21 | PNP | | 25 | 200 | 75 | 2 | 4.5 | 0.5 | 50 | 3 | 150 | 10 | |
| BSW21A | PNP | | 50 | 200 | 75 | 2 | 4.5 | 0.5 | 50 | 3 | 150 | 10 | |
| BSW22 | PNP | | 25 | 200 | 180 | 2 | 4.5 | 0.5 | 50 | 3 | 150 | 10 | |
| BSW22A | PNP | | 50 | 200 | 180 | 2 | 4.5 | 0.5 | 50 | 3 | 150 | 10 | |
| BC107 | | NPN | 45 | 100 | 110 | 2 | 5.0 | 0.6 | 100 | 5 | 150 | 10 | EXISTS IN A, B, HFE GROUPS |
| BC108 | | NPN | 20 | 100 | 110 | 2 | 5.0 | 0.8 | 100 | 5 | 150 | 10 | EXISTS A, B, and C, HFE GROUPS |
| BCY58 | | NPN | 32 | 200 | 120 | 2 | 5.0 | 0.7 | 100 | 2.5 | 125 (-) | 10 | EXISTS VII, VIII, IX, X, HFE GROUPS |
| BCY59 | | NPN | 45 | 200 | 120 | 2 | 5.0 | 0.7 | 100 | 2.5 | 125 | 10 | |
| BCY66E | | NPN | 60 | 200 | 120 | 2 | 5.0 | 0.7 | 50 | 1.25 | 125 (-) | 10 | EXISTS VII, VIII, IX, HFE GROUPS |
| BSX51 | | NPN | 25 | 200 | 75 | 2 | 4.5 | 0.3 | 50 | 3 | 150 | 10 | |
| BSX51A | | NPN | 50 | 200 | 75 | 2 | 4.5 | 0.3 | 50 | 3 | 150 | 10 | |
| BSX51B | | NPN | 60 | 200 | 75 | 2 | 4.5 | 0.3 | 50 | 3 | 150 | 10 | |
| BSX52 | | NPN | 25 | 200 | 180 | 2 | 4.5 | 0.3 | 50 | 3 | 150 | 10 | |
| BSX52A | | NPN | 50 | 200 | 180 | 2 | 4.5 | 0.3 | 50 | 3 | 150 | 10 | |
| BSW52B | | NPN | 60 | 200 | 180 | 2 | 4.5 | 0.3 | 50 | 3 | 150 | 10 | |

FAST SPEED SWITCHING TRANSISTORS (TO-18)

| Device Type | Polarity | V _{CEO} V _{CER} (—) V | I _C max | H _{FE} at | I _C (mA) | V _{CE} V | V _{CE} max (V) | I _C (mA) | I _B (mA) | T _{on} (ns) | T _S (ns) | T _{off} (ns) | I _C (mA) | I _{B1} (mA) | I _{B2} (mA) |
|-------------|----------|--|-----------------------|--------------------|------------------------|-----------------------|-------------------------------|------------------------|------------------------|-------------------------|------------------------|--------------------------|------------------------|-------------------------|-------------------------|
| BSX90 | NPN | 12 | 200 | 20 | 10 | 0.35 | 1.0 | 100 | 10 | 12 | — | 40 | 100 | 40 | 20 |
| BSX29 | PNP | 12 | 200 | 30 | 30 | 0.5 | 0.5 | 100 | 10 | 60 | 18 | 90 | 30 | 3 | 3 |

LOW NOISE AMPLIFIER

| LOW NOISE AMPLIFIER | | | | | | | | | | | | |
|---------------------|-----|-----|---------------------------|----------------------------|---------------------------|------------------------|----------------------------|----------------------|--------------------------|------------------------|-----------------------------------|------------------------|
| DEVICE TYP | NPN | PNP | V _{CEO} (VDC) | I _C max (mA) | H _{FE} AT min | I _C (mA) | V _{CE} (Volts) | NF AT (DB) max | V _{CE} (VDC) | I _C (mA) | f _T AT (MHz) min | I _C (mA) |
| BC109 | NPN | | 20 | 30 | 220 | 2 | 5 | 4 | 5 | 0.2 | 150 | 10 |
| BC179 | | PNP | 20 | 100 | 120 | 2 | 5 | 4 | 5 | 0.2 | 130 | 10 |

POWER PLASTIC TRANSISTORS

GENERAL PURPOSE TRANSISTORS – EPIBASE TECHNOLOGY

| NPN | PNP | V_{CE0} Volts | P_D Watts | I_{Cmax} Amps | h_{fe} min | @ I_C Amps | & V_{CE} Volts | V_{CESat} Volts | @ I_C Amps | f_T MHz | Case |
|--------|-------|--------------------|----------------|--------------------|-----------------|-----------------|---------------------|----------------------|-----------------|--------------|------|
| BD165 | BD166 | 45 | 20.0 | 1.5 | 15 | 0.5 | 2.0 | 0.50 | 0.50 | 6 | 77 |
| BD167 | BD168 | 60 | 20.0 | 1.5 | 15 | 0.5 | 2.0 | 0.50 | 0.50 | 6 | 77 |
| BD169 | BD170 | 80 | 20.0 | 1.5 | 15 | 0.5 | 2.0 | 0.50 | 0.50 | 6 | 77 |
| BD233 | BD234 | 45 | 25.0 | 2.0 | 25 | 1.0 | 2.0 | 0.6 | 1.0 | 3.0 | 77 |
| BD235 | BD236 | 60 | 25.0 | 2.0 | 25 | 1.0 | 2.0 | 0.6 | 1.0 | 3.0 | 77 |
| BD237 | BD238 | 80 | 25.0 | 2.0 | 25 | 1.0 | 2.0 | 0.6 | 1.0 | 3.0 | 77 |
| BD175 | BD176 | 45 | 30.0 | 3.0 | 15 | 1.0 | 2.0 | 0.8 | 1.0 | 3.0 | 77 |
| BD177 | BD178 | 60 | 30.0 | 3.0 | 15 | 1.0 | 2.0 | 0.8 | 1.0 | 3.0 | 77 |
| BD179 | BD180 | 80 | 30.0 | 3.0 | 15 | 1.0 | 2.0 | 0.8 | 1.0 | 3.0 | 77 |
| BD433 | BD434 | 22 | 40 | 4.0 | 85 | 0.5 | 1.0 | 0.5 | 2.0 | 3.0 | 77 |
| BD435 | BD436 | 32 | 40 | 4.0 | 85 | 0.5 | 1.0 | 0.5 | 2.0 | 3.0 | 77 |
| BD437 | BD438 | 45 | 40 | 4.0 | 85 | 0.5 | 1.0 | 0.7 | 3.0 | 3.0 | 77 |
| BD439 | BD440 | 60 | 40 | 4.0 | 40 | 0.5 | 1.0 | 0.8 | 3.0 | 3.0 | 77 |
| BD441 | BD442 | 80 | 40 | 4.0 | 40 | 0.5 | 1.0 | 0.8 | 3.0 | 3.0 | 77 |
| BD443 | | 100 | 30 | 3.0 | 40 | 0.5 | 2.0 | 0.7 | 1.0 | 0.8 | 77 |
| BD443A | | 100 | 30 | 3.0 | 40 | 0.5 | 2.0 | 1.2 | 0.5 | 0.8 | 77 |
| BD561 | BD562 | 40 | 40 | 4.0 | 40 | 2.0 | 1.0 | 0.5 | 1.0 | 3.0 | 77 |
| BD575 | BD576 | 45 | 30.0 | 3.0 | 25 | 1.0 | 2.0 | 0.6 | 1.0 | 3.0 | 199 |
| BD577 | BD578 | 60 | 30.0 | 3.0 | 25 | 1.0 | 2.0 | 0.6 | 1.0 | 3.0 | 199 |
| BD579 | BD580 | 80 | 30.0 | 3.0 | 15 | 1.0 | 2.0 | 0.8 | 1.0 | 3.0 | 199 |
| BD581 | BD582 | 100 | 30.0 | 3.0 | 15 | 1.0 | 3.0 | 0.8 | 1.0 | 3.0 | 199 |
| BD185 | BD186 | 30 | 40.0 | 4.0 | 15 | 2.0 | 2.0 | 1.0 | 2.0 | 2.0 | 77 |
| BD187 | BD188 | 45 | 40.0 | 4.0 | 15 | 2.0 | 2.0 | 1.0 | 2.0 | 2.0 | 77 |
| BD189 | BD190 | 60 | 40.0 | 4.0 | 15 | 2.0 | 2.0 | 1.0 | 2.0 | 2.0 | 77 |
| BD585 | BD586 | 45 | 40.0 | 3.0 | 25 | 2.0 | 2.0 | 0.8 | 2.0 | 3.0 | 199 |
| BD587 | BD588 | 60 | 40.0 | 4.0 | 25 | 2.0 | 0.8 | 0.8 | 2.0 | 3.0 | 199 |
| BD589 | BD590 | 80 | 40.0 | 4.0 | 15 | 2.0 | 2.0 | 0.8 | 2.0 | 3.0 | 199 |
| BD591 | BD592 | 100 | 40.0 | 4.0 | 15 | 2.0 | 2.0 | 0.8 | 2.0 | 3.0 | 199 |
| BD195 | BD196 | 30 | 65.0 | 6.0 | 15 | 3.0 | 2.0 | 1.0 | 3.0 | 2.0 | 90 |
| BD197 | BD198 | 45 | 65.0 | 6.0 | 15 | 3.0 | 2.0 | 1.0 | 3.0 | 2.0 | 90 |
| BD199 | BD200 | 60 | 65.0 | 6.0 | 15 | 3.0 | 2.0 | 1.0 | 3.0 | 2.0 | 90 |
| BD595 | BD596 | 45 | 55.0 | 8.0 | 25 | 3.0 | 2.0 | 1.0 | 3.0 | 3.0 | 199 |
| BD597 | BD598 | 60 | 55.0 | 8.0 | 25 | 3.0 | 2.0 | 1.0 | 3.0 | 3.0 | 199 |
| BD599 | BD600 | 80 | 55.0 | 8.0 | 15 | 3.0 | 2.0 | 1.0 | 3.0 | 3.0 | 199 |
| BD601 | BD602 | 100 | 55.0 | 8.0 | 15 | 3.0 | 2.0 | 1.0 | 3.0 | 3.0 | 199 |
| BD205 | BD206 | 45 | 90.0 | 10.0 | 15 | 4.0 | 2.0 | 1.1 | 4.0 | 1.5 | 90 |
| BD207 | BD208 | 60 | 90.0 | 10.0 | 15 | 4.0 | 2.0 | 1.1 | 4.0 | 1.5 | 90 |
| BD605 | BD606 | 45 | 90.0 | 10.0 | 15 | 4.0 | 2.0 | 1.1 | 4.0 | 1.5 | 199 |
| BD607 | BD608 | 60 | 90.0 | 10.0 | 15 | 4.0 | 2.0 | 1.1 | 4.0 | 1.5 | 199 |
| BD609 | BD610 | 90 | 90.0 | 10.0 | 15 | 4.0 | 2.0 | 1.1 | 4.0 | 1.5 | 199 |

GENERAL PURPOSE DARLINGTONS — EPIBASE TECHNOLOGY

| NPN | PNP | V_{CE} Volts | P_D Watts | I_{Cmax} Amps | h_{fe} min | @ I_C Amps | ΔV_{CE} Volts | V_{CESat} Volts | @ I_C Amps | f_T MHz | Case |
|--------|--------|-------------------|----------------|--------------------|-----------------|-----------------|--------------------------|----------------------|-----------------|--------------|------|
| BD675 | BD676 | 45 | 40.0 | 4.0 | 750 | 1.5 | 3.0 | 2.5 | 1.5 | 1.0 | 77 |
| BD675A | BD676A | 45 | 40.0 | 4.0 | 750 | 2.0 | 3.0 | 2.8 | 2.0 | 1.0 | 77 |
| BD677 | BD678 | 60 | 40.0 | 4.0 | 750 | 1.5 | 3.0 | 2.5 | 1.5 | 1.0 | 77 |
| BD677A | BD678A | 60 | 40.0 | 4.0 | 750 | 2.0 | 3.0 | 2.8 | 2.0 | 1.0 | 77 |
| BD679 | BD680 | 80 | 40.0 | 4.0 | 750 | 1.5 | 3.0 | 2.5 | 1.5 | 1.0 | 77 |
| BD679A | BD680A | 80 | 40.0 | 4.0 | 750 | 2.0 | 3.0 | 2.8 | 2.0 | 1.0 | 77 |
| BD695 | BD696 | 45 | 70.0 | 8.0 | 750 | 3.0 | 3.0 | 2.5 | 3.0 | 1.0 | 199 |
| BD695A | BD696A | 45 | 70.0 | 8.0 | 750 | 4.0 | 3.0 | 2.8 | 4.0 | 1.0 | 199 |
| BD697 | BD698 | 60 | 70.0 | 8.0 | 750 | 3.0 | 3.0 | 2.5 | 3.0 | 1.0 | 199 |
| BD697A | BD698A | 60 | 70.0 | 8.0 | 750 | 4.0 | 3.0 | 2.8 | 4.0 | 1.0 | 199 |
| BD699 | BD700 | 80 | 70.0 | 8.0 | 750 | 3.0 | 3.0 | 2.5 | 3.0 | 1.0 | 199 |
| BD699A | BD700A | 80 | 70.0 | 8.0 | 750 | 4.0 | 3.0 | 2.8 | 4.0 | 1.0 | 199 |
| BD701 | BD702 | 100 | 70.0 | 8.0 | 750 | 3.0 | 3.0 | 2.5 | 3.0 | 1.0 | 199 |

HIGH SPEED TRANSISTORS — PLANAR TECHNOLOGY

| NPN | PNP | V_{CE} Volts | P_D Watts | I_{Cmax} Amps | h_{fe} min | @ I_C Amps | ΔV_{CE} Volts | V_{CESat} Volts | @ I_C Amps | f_T MHz | Case |
|----------|----------|-------------------|----------------|--------------------|-----------------|-----------------|--------------------------|----------------------|-----------------|--------------|------|
| BD361 | BD362 | 20 | 15 | 4.0 | 25 | 2.0 | 1 | 0.8 | 1.0 | 40 | 77 |
| BD361A | BD362A | 20 | 15 | 4.0 | 50 | 2.0 | 1 | 0.8 | 1.0 | 40 | 77 |
| BD135 | BD136 | 45 | 10 | 1.5 | 40 | 0.15 | 2 | 0.5 | 0.5 | 40 | 77 |
| BD135-6 | BD136-6 | 45 | 10 | 1.5 | 40 | 0.15 | 2 | 0.5 | 0.5 | 40 | 77 |
| BD135-10 | BD136-10 | 45 | 10 | 1.5 | 63 | 0.15 | 2 | 0.5 | 0.5 | 40 | 77 |
| BD135-16 | BD136-16 | 45 | 10 | 1.5 | 100 | 0.15 | 2 | 0.5 | 0.5 | 40 | 77 |
| BD137 | BD137 | 60 | 10 | 1.5 | 40 | 0.15 | 2 | 0.5 | 0.5 | 40 | 77 |
| BD137-6 | BD137-6 | 60 | 10 | 1.5 | 40 | 0.15 | 2 | 0.5 | 0.6 | 40 | 77 |
| BD137-10 | BD137-10 | 60 | 10 | 1.5 | 63 | 0.15 | 2 | 0.5 | 0.5 | 40 | 77 |
| BD139 | BD140 | 80 | 10 | 1.6 | 40 | 0.15 | 2 | 0.5 | 0.5 | 40 | 77 |
| BD139-6 | BD140-6 | 80 | 10 | 1.5 | 40 | 0.15 | 2 | 0.5 | 0.5 | 40 | 77 |
| BD139-10 | BD140-10 | 80 | 10 | 1.5 | 63 | 0.15 | 2 | 0.5 | 0.5 | 40 | 77 |
| BD785 | BD786 | 45 | 15 | 4.0 | 40 | 0.2 | 3 | 0.6 | 1.0 | 40 | 77 |
| BD787 | BD788 | 60 | 15 | 4.0 | 40 | 0.2 | 3 | 0.6 | 1.0 | 40 | 77 |
| BD789 | BD790 | 80 | 15 | 4.0 | 40 | 0.2 | 3 | 0.5 | 0.5 | 40 | 77 |
| BD791 | BD792 | 100 | 15 | 4.0 | 40 | 0.2 | 3 | 0.5 | 0.5 | 40 | 77 |

HIGH SPEED DARLINGTONS — PLANAR TECHNOLOGY

| NPN | PNP | V_{CE} Volts | P_D Watts | I_{Cmax} Amps | h_{fe} min | @ I_C Amps | ΔV_{CE} Volts | V_{CESat} Volts | @ I_C Amps | f_T MHz | Case |
|-------|-------|-------------------|----------------|--------------------|-----------------|-----------------|--------------------------|----------------------|-----------------|--------------|------|
| BD775 | BD776 | 45 | 15 | 4 | 750 | 2.0 | 3.0 | 1.5 | 2.0 | 20 | 77 |
| BD777 | BD778 | 60 | 15 | 4 | 750 | 2.0 | 3.0 | 1.5 | 2.0 | 20 | 77 |
| BD779 | BD790 | 80 | 15 | 4 | 750 | 2.0 | 3.0 | 1.5 | 2.0 | 20 | 77 |

HIGH VOLTAGE TRANSISTORS – TRIPLE DIFFUSED TECHNOLOGY

| NPN | PNP | V_{CE0} Volts | P_D Watts | I_{Cmax} Amps | h_{fe} min | @ I_C Amps | & V_{CE} Volts | V_{CESat} Volts | @ I_C Amps | f_T MHz | Case |
|-------|-----|--------------------|----------------|--------------------|-----------------|-----------------|---------------------|----------------------|-----------------|--------------|------|
| 8Q157 | | 250 | 20.0 | 0.5 | 30 | 0.05 | 10 | 0.25* | 0.05 | 10 | 77 |
| 8Q158 | | 300 | 20.0 | 0.5 | 30 | 0.05 | 10 | 0.25* | 0.05 | 10 | 77 |
| 8Q159 | | 350 | 20.0 | 0.5 | 30 | 0.05 | 10 | 0.25* | 0.15 | 10 | 77 |
| 8Q232 | | 300 | 20.0 | 1.0 | 20 | 0.15 | 5 | 1.0 | 0.15 | 10 | 77 |
| 8Q457 | | 160 | 12.5 | 0.1 | 25 | 0.03 | 10 | 1.0 | 0.03 | 40 | 77 |
| 8Q458 | | 250 | 12.5 | 0.1 | 25 | 0.03 | 10 | 1.0 | 0.03 | 40 | 77 |
| 8Q459 | | 300 | 13.5 | 0.1 | 25 | 0.03 | 10 | 1.0 | 0.03 | 40 | 77 |

POWER METAL TRANSISTORS

GENERAL PURPOSE TRANSISTORS – EPIBASE TECHNOLOGY

| NPN | PNP | V_{CE0} Volts | P_D Watts | I_{Cmax} Amps | h_{fe} min | @ I_C Amps | & V_{CE} Volts | V_{CESat} Volts | @ I_C Amps | f_T MHz | Case |
|-------|-------|--------------------|----------------|--------------------|-----------------|-----------------|---------------------|----------------------|-----------------|--------------|-------|
| 8Q142 | | 40 | 117 | 15.0 | 12.5 | 4.0 | 4.0 | 1.1 | 4.0 | 2.0 | TO-3 |
| 8Q311 | 8Q312 | 60 | 150 | 10.0 | 25.0 | 5.0 | 4.0 | 1.0 | 5.0 | 4.0 | TO-3 |
| 8Q313 | 8Q314 | 80 | 150 | 10.0 | 25.0 | 4.0 | 4.0 | 1.0 | 5.0 | 4.0 | TO-3 |
| 8Q315 | 8Q316 | 80 | 200 | 16.0 | 25.0 | 8.0 | 4.0 | 1.0 | 8.0 | 1.0 | TO-3 |
| 8Q317 | 8Q318 | 100 | 200 | 16.0 | 25.0 | 5.0 | 4.0 | 1.0 | 8.0 | 1.0 | TO-3 |
| 8Q364 | 8Q365 | 50 | 200 | 25.0 | 25.0 | 7.0 | 4.0 | 1.0 | 10.0 | 4.0 | TO-3 |
| 8Q366 | 8Q367 | 60 | 200 | 25.0 | 25.0 | 7.0 | 4.0 | 1.0 | 10.0 | 4.0 | TO-3 |
| 8Q368 | 8Q369 | 80 | 200 | 25.0 | 25.0 | 7.0 | 4.0 | 1.0 | 10.0 | 4.0 | TO-3 |
| 8Q342 | 8Q343 | 40 | 100 | 12.0 | 15.0 | 3.0 | 4.0 | 1.5 | 4.0 | 1.5 | TO-3 |
| 8QX55 | | 45 | 12 | 7.0 | 40.0 | 2.0 | 2.0 | 1.0 | 5.0 | 4.0 | TO-39 |
| 8QX56 | | 60 | 12 | 7.0 | 40.0 | 2.0 | 2.0 | 1.0 | 5.0 | 4.0 | TO-39 |
| 8QX57 | | 80 | 12 | 7.0 | 40.0 | 2.0 | 2.0 | 1.0 | 5.0 | 4.0 | TO-39 |

HIGH VOLTAGE TRANSISTORS – TRIPLE DIFFUSED TECHNOLOGY

| NPN | PNP | V_{CE0} Volts | P_D Watts | I_{Cmax} Amps | h_{fe} min | @ I_C Amps | & V_{CE} Volts | V_{CESat} Volts | @ I_C Amps | f_T MHz | Case |
|--------|-----|--------------------|----------------|--------------------|-----------------|-----------------|---------------------|----------------------|-----------------|--------------|------|
| 8U126 | | 300 | 40 | 6 | 15.0 | 1.0 | 5.0 | 5.0 | 4.0 | *8.0 | TO-3 |
| 8U126A | | 250 | 40 | 6 | 15.0 | 1.0 | 5.0 | 5.0 | 4.0 | *8.0 | TO-3 |
| 8U205 | | 700 | 26 | 3 | 2.0 | 2.0 | 5.0 | 5.0 | 2.0 | *8.0 | TO-3 |
| 8U208 | | 700 | 56 | 5 | 2.25 | 4.5 | 5.0 | 5.0 | 4.5 | *7.0 | TO-3 |
| 8U222 | | 350 | 100 | 6 | 3.0 | 6.0 | 2.5 | 1.5 | 4.0 | *7.5 | TO-3 |
| 8U222A | | 425 | 100 | 6 | 3.0 | 6.0 | 2.5 | 1.5 | 4.0 | *7.5 | TO-3 |
| 8U223 | | 350 | 125 | 10 | 3.3 | 10.0 | 2.5 | 1.5 | 7.0 | *7.5 | TO-3 |
| 8U223A | | 425 | 125 | 10 | 3.3 | 10.0 | 2.5 | 1.5 | 7.0 | *7.5 | TO-3 |
| 8UY29 | | 200 | 125 | 8 | 15.0 | 3.0 | 5.0 | 2.0 | 3.5 | 5.0 | TO-3 |
| 8UY30 | | 250 | 125 | 8 | 15.0 | 3.0 | 5.0 | 2.0 | 3.5 | 5.0 | TO-3 |

* Typical

HIGH VOLTAGE DARLINGTONS – TRIPLE DIFFUSED TECHNOLOGY

| NPN | PNP | V_{CE0} Volts | P_D Watts | I_{Cmax} Amps | h_{fe} min | @ I_C Amps | & V_{CE} Volts | V_{CESat} Volts | @ I_C Amps | f_T MHz | Case |
|--------|-----|--------------------|----------------|--------------------|-----------------|-----------------|---------------------|----------------------|-----------------|--------------|------|
| 8U322 | | 350 | 100 | 7 | 23 | 7 | 2.7 | 1.7 | 4.0 | 7.5 | TO-3 |
| 8U322A | | 425 | 100 | 7 | 23 | 7 | 2.7 | 1.7 | 4.0 | 7.5 | TO-3 |
| 8U323 | | 350 | 125 | 10 | 25 | 10 | 2.7 | 1.7 | 6.0 | 7.5 | TO-3 |
| 8U323A | | 425 | 125 | 10 | 25 | 10 | 2.7 | 1.7 | 6.0 | 7.5 | TO-3 |

RF TRANSISTORS

HIGH FREQUENCY TRANSISTORS

| NPN | BV_{CEO} min | P_{Dmax} mW | I_C max mA | $h_{FE} @$ min | I_C mA | V_{CE} & Volts | f_{Ttyp} GHz | C_{eb} max Pf | NF @ dB | f GHz | Package |
|-------|-------------------|------------------|--------------------|-------------------|-------------|---------------------|-------------------|-----------------------|------------|----------|---------|
| BFR90 | 15 | 180 | 30 | 25 | 14 | 10 | 5.0 | 1.0 | 2.4 | 0.5 | SOT-2 |
| BFR91 | 12 | 180 | 35 | 25 | 30 | 5 | 5.0 | 1.0 | 1.9 | 0.5 | SOT-2 |
| BFX90 | 15 | 200 | 50 | 20 | 25 | 1 | 1.8 | 1.5 | 5.0 | 0.5 | TO-72 |
| BFX89 | 15 | 200 | 50 | 20 | 25 | 1 | 1.2 | 1.7 | 6.5 | 0.5 | TO-72 |

ZENER DIODES

ZENER DIODES DO-7

| | | | | | |
|---------|---|-------|--------|----------------------|--|
| GLASS | { | DO-35 | BZX79B | 2.4 – 200V 2%/o tol. | 400 mW axial lead |
| | | DO-35 | BZX79C | 2.4 – 200V 5%/o tol. | 400 mW axial lead |
| PLASTIC | { | DO-7 | BZY88C | 3.3 – 33V 5%/o tol. | 10%/o preferred voltage range. 400 mW axial lead |
| | | DO-41 | MZD | 3.9 – 200 5%/o tol. | 1 W axial lead |
| | | DO-7 | MZF | 2.7 – 33V 5%/o tol. | 10%/o preferred voltage range. 500 mW axial lead |

RECTIFIERS

STANDARD RECOVERY RECTIFIERS -- CASE 59-04

| DEVICES | V _{RRM} (VOLTS) | I _O (AMPS) | I _{FSM} (AMPS) | I _R (μA) | V _F (VOLTS) |
|---------|-----------------------------|-----------------------|-------------------------|---------------------|---------------------------|
| BY126 | 650 | 1 | 40 | 10 | 1.5 |
| BY127 | 1250 | 1 | 40 | 10 | 1.5 |
| BY133 | 1300 | 1 | 50 | 5 | 1.3 |
| BY134 | 600 | 1 | 50 | 5 | 1.3 |
| BY135 | 150 | 1 | 50 | 5 | 1.3 |
| BYX10 | 1600 | 0.36 | 30 | 1 | 1.6 |

CASE OUTLINE
(CASE 59-04)

CASE DIMENSIONS (MM)

SOFT/FAST RECOVERY RECTIFIERS -- CASE 59-04

| DEVICES | V _{RRM} (VOLTS) | I _O (AMPS) | I _{FSM} (AMPS) | I _R (μA) | V _F (VOLTS) | t _{rr1} (nS) | t _{rr2} (nS) |
|------------|-----------------------------|-----------------------|-------------------------|---------------------|------------------------|-----------------------|-----------------------|
| BA 145 | 350 | 0.4 | 15 | 2 μA | 1.0 V | 350 nS | 750 nS |
| BA 148 | 350 | 0.4 | 15 | 2 μA | 1.0 V | 450 nS | 750 nS |
| BA 157 | 400 | 0.4 | 15 | 5 μA | 1.3 V | 300 nS | |
| BA 158 | 600 | 0.4 | 15 | 5 μA | 1.3 V | 300 nS | |
| BA 159 | 1000 | 0.4 | 15 | 5 μA | 1.3 V | 300 nS | |
| BY 196 | 100 | 1.2 | 70 | 10 μA | 1.3 V | 500 nS | |
| BY 197 | 200 | 1.2 | 70 | 10 μA | 1.3 V | 500 nS | |
| BY 198 | 400 | 1.2 | 70 | 10 μA | 1.3 V | 500 nS | |
| BY 199 | 800 | 1.2 | 70 | 10 μA | 1.3 V | 500 nS | |
| BY 206 | 350 | 0.5 | 15 | 2 μA | 1.3 V | 300 nS | 1000 nS |
| BY 207 | 600 | 0.5 | 15 | 2 μA | 1.3 V | 300 nS | 1000 nS |
| BY 210/4 | 400 | 1.0 | 30 | 10 μA | 1.4 V | 300 nS | 750 nS |
| BY 210/6 | 600 | 1.0 | 30 | 10 μA | 1.4 V | 300 nS | 750 nS |
| BY 210/B | 800 | 1.0 | 30 | 10 μA | 1.4 V | 300 nS | 750 nS |
| BY 330 | 50 | 1.0 | 30 | 10 μA | 1.25 V | 500 nS | 750 nS |
| BY 331 | 100 | 1.0 | 40 | 10 μA | 1.25 V | 500 nS | 750 nS |
| BY 332 | 200 | 1.0 | 40 | 10 μA | 1.25 V | 500 nS | 750 nS |
| BY 333 | 300 | 1.0 | 40 | 10 μA | 1.25 V | 500 nS | 750 nS |
| BY 334 | 400 | 1.0 | 40 | 10 μA | 1.25 V | 500 nS | 750 nS |
| BY 336 | 500 | 1.0 | 40 | 10 μA | 1.25 V | 500 nS | 750 nS |
| BY 337 | 800 | 1.0 | 40 | 10 μA | 1.25 V | 500 nS | 750 nS |
| BY 338 | 1000 | 1.0 | 40 | 10 μA | 1.25 V | 500 nS | 750 nS |
| BYX 55/350 | 350 | 1.2 | 40 | 10 μA | 1.25 V | 350 nS | 750 nS |
| BYX 55/600 | 600 | 1.2 | 40 | 10 μA | 1.25 V | 350 nS | 750 nS |

SDFT/FAST RECOVERY RECTIFIERS – CASE 267-01

| DEVICES | V _{RRM} | I _O (AMPS) | I _{FSM} (AMPS) | I _R (μA) | V _F (VOLTS) | T _{rr1} (nS) | T _{rr2} (nS) |
|---------|------------------|-----------------------|-------------------------|---------------------|------------------------|-----------------------|-----------------------|
| BY 296 | 100 | 2 | 70 | 10 | 1.3 | 500 | 750 |
| BY 297 | 200 | 2 | 70 | 10 | 1.3 | 500 | 750 |
| BY 298 | 400 | 2 | 70 | 10 | 1.3 | 500 | 750 |
| BY 299 | 800 | 2 | 70 | 10 | 1.3 | 500 | 750 |
| MR 910 | 50 | 3 | 100 | 10 | 1.25 | 300 | 750 |
| MR 911 | 100 | 3 | 100 | 10 | 1.25 | 300 | 750 |
| MR 912 | 200 | 3 | 100 | 10 | 1.25 | 300 | 750 |
| MR 913 | 300 | 3 | 100 | 10 | 1.25 | 300 | 750 |
| MR 914 | 400 | 3 | 100 | 10 | 1.25 | 300 | 750 |
| MR 916 | 600 | 3 | 100 | 10 | 1.25 | 300 | 750 |
| MR 917 | 800 | 3 | 100 | 10 | 1.25 | 300 | 750 |
| MR 918 | 1000 | 3 | 100 | 10 | 1.25 | 300 | 750 |

RECTIFIER BRIDGES – SINGLE PHASE FULL WAVE DEVICES – CASE 309-01

| DEVICES | V _{RRM} | I _O (AMPS) | I _{FSM} (AMPS) | I _R (mA) | V _F (VOLTS) |
|---------|------------------|-----------------------|-------------------------|---------------------|------------------------|
| BYW 20 | 50 | 15 | 400 | 0.5 | 0.97 |
| BYW 21 | 100 | 15 | 400 | 0.5 | 0.97 |
| BYW 22 | 200 | 15 | 400 | 0.5 | 0.97 |
| BYW 23 | 300 | 15 | 400 | 0.5 | 0.97 |
| BYW 24 | 400 | 15 | 400 | 0.5 | 0.97 |
| BYW 26 | 600 | 15 | 400 | 0.5 | 0.97 |
| BYW 28 | 800 | 15 | 400 | 0.5 | 0.97 |
| BYW 60 | 50 | 35 | 400 | 0.5 | 1.07 |
| BYW 61 | 100 | 35 | 400 | 0.5 | 1.07 |
| BYW 62 | 200 | 35 | 400 | 0.5 | 1.07 |
| BYW 63 | 300 | 35 | 400 | 0.5 | 1.07 |
| BYW 64 | 400 | 35 | 400 | 0.5 | 1.07 |
| BYW 65 | 600 | 35 | 400 | 0.5 | 1.07 |
| BYW 68 | 800 | 35 | 400 | 0.5 | 1.07 |

SPECIAL PURPOSE DIODES
SPECIAL PURPOSE DIODES – CASE 226

| | V _R | P _D mW | I _F mA | Brief Spec. | Type Service |
|--------|----------------|-------------------|-------------------|---|----------------------|
| BA 382 | 40 | 250 | — | R _s 0.8Ω @ 4 mA | Pin switching |
| BB 105 | 30 | 250 | 200 | 2 – 10 pF C _s /C ₂₅ | Voltage variable cap |
| BB 305 | 35 | 250 | 200 | 2 – 10 pF C _s /C ₂₅ | Voltage variable cap |

LINEAR INTEGRATED CIRCUITS

IF AMPLIFIERS

| Type | Description | V _{CC} max | I _{CC} typ μA | 3 dB limiting input signal typ | AM rejection typ | Package |
|-----------|--|------------------------|------------------------------|--------------------------------------|------------------------|----------------------------|
| TBA 120 C | FM IF amplifier, limiter, detector and audio preamplifier. Improved DC volume control. | 18 V | 14 mA | 35 μV rms | 50 dB | Plastic TO-116 CASE 646 |
| TBA 120 D | FM IF amplifier, limiter, detector. Pin for pin compatible with TBA 120. | 18 V | 14 mA | 35 μV rms | 50 dB | Plastic TO-116 CASE 646 |

COLOR PROCESSORS

| Type | Description | V _{CC} max | I _{CC} typ | P _D mW | Package |
|----------|---|------------------------|------------------------|----------------------|----------------------------|
| TBA 396 | Luminance and chrominance control system for PAL. | 20 V | 7 mA | 625 | Plastic TO-116 CASE 646 |
| TBA 3950 | PAL chroma processing system | — | 60 mA max | 625 | Plastic TO-116 CASE 646 |

STEREO DECODERS

| Type | Description | V _{CC} | Channel separation | distortion | Output voltage | Z _{out} | Package |
|----------|--|-----------------|-----------------------|----------------------|---------------------|------------------|--------------------------------------|
| TCA 4500 | PLL Stereo decoder. Improved version of MC 1310. Unity or 6 dB gain. | 8-18 V | 40 dB min | 0.1% at 0.5 V rms | 1.5 V rms max | 200Ω | 16 pin Plastic TO-116 CASE 648 |

TRIAC CONTROL

| Type | Description | V _{CC} max | I _{CC} typ | Firing current | Bias current | Output pulse width | Operating temperature | Package |
|-------------|--|------------------------|------------------------|-------------------|-----------------|-----------------------|--------------------------|-----------------------------------|
| UAA 1004 DP | Zero voltage switch for ON-OFF power control; differential input | 20 V | 2 mA | 80 mA | 1 μA | 100 μs | -20° to +75° C | 8 pin DIL CASE 626 |
| UAA 1004 CM | | | | | | | -55° to +125° C | 8 pin TO-99 CASE 601 |
| UAA 1006 DP | Zero voltage switch for proportional power control; differential input | 20 V | 3.5 mA | 80 mA | 0.5 μA | programmable | -20° to +75° C | 16 pin plastic DIL CASE 648 |

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